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# SURGERY, GYNECOLOGY AND OBSTETRICS

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## THE MORPHOLOGICAL SIMILARITY OF CERTAIN LUTEAL CYSTS AND ENDOMETRIOSIS OF THE OVARY

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EXAMINATION of the records of blood cysts of the ovary of the past three decades discloses the fact that the diagnosis of endometriosis of the ovary is frequently found while mention of other conditions particularly the tarry luteal cysts is rare. Previously the blood cysts with the exception of the obviously luteal formed a heterogeneous group for which numerous hypotheses had been put forward.

The first suggestion that some of these cysts were endometrial (muellerian) in origin was made by Russell in 1899 and this idea was seized upon and since that time many reports of cases ascribe this origin to similar cysts.

It was about the same period (1898) that Fraenkel (5) showed that some of the luteal cysts containing old blood developed a lining of columnar cells. Many luteal cysts leave little doubt as to their origin, but some of them lose many of the characteristics by which their origin may be easily recognized. It is these atypical forms which it is proposed to discuss and particularly those which have developed the 'epithelial lining described by Fraenkel.

*A priori* since corpora lutea occur so commonly in the ovary one would expect to find changes in them much more frequently rather than to discover a curiously aberrant tissue—endometrium which is apparently derived from a neighboring organ.

Is it that the luteal cysts are too obvious to raise question and of too little interest to be more than noticed? Or has the possibility of the luteal origin of the epithelium lined glands and cysts been overlooked? A consideration of the microscopic appearances and one at least of the complications of these luteal cysts will readily make it clear that they occur more commonly than, and equal in interest, those of 'endometrial' character.

The effect of the rupture of endometrial cysts on the peritoneum, with the development of secondary endometrial growths and a resulting severe inflammatory reaction has been frequently described. Why is it, though, that a similarly severe reaction to the presence of luteal cells derived from a tarry luteal cyst has been almost unnoticed? Brakeman and Shaw have reported cases of this most interesting condition and the writer has observed a case in which a similar phenomenon occurred.

In view of these circumstances, a description and discussion of tarry luteal cysts and their relation to endometriosis will not be out of place.

That failure to differentiate the two conditions sometimes occurs was suggested by the observations (1) that the diagnosis of endometriosis was made in cases of luteal cysts showing the epithelial lining and (2) that the evidence on which the conclusion of the endometrial origin is based, in some reported

cases is inadequate and in some cases even suggests a luteal origin. It is possibly the suggestion of the bizarre in the diagnosis of endometriosis that appeals to the imagination.

There are of course some cases in which the evidence at present allows only of a diagnosis of 'endometrial' glands but it is proposed to show that other sources should be considered before concluding that the cysts are necessarily of müllerian origin.

#### ENDOMETRIAL CYSTS OF THE OVARY

Endometrial structures found in the ovary take the form of glands and by the distention of these cysts. These cysts usually contain chocolate or tarry material which is derived from old blood. On this hypothesis the reason given for the bleeding is that since the glands functionally as well as morphologically resemble those of the normal endometrium hemorrhage occurs into them during menstruation (2).

The glands frequently occur on the surface of the organ and adhesions form between the ovary and the neighboring structures (14, 16). This is due to the implantation of the glands on the surface of the surrounding organs and to the subsequent fibrosis inaugurated by the presence of the gland tissue. This characteristic will be referred to later.

Sometimes the cysts reach a size of several (3 to 6) centimeters and rupture may occur into the peritoneal cavity.

Microscopically the glands are lined with columnar epithelium which has a supporting stroma similar to that of the endometrium of the uterus (15). Around this again is the tissue of the surrounding organ fibrous tissue—and in some places muscle.

While this is the typical appearance many variations occur the epithelium may become flattened the stroma may disappear thus leaving little but neighboring characteristic glands to give a clue to the true diagnosis.

It would appear thus that in a typical case there could be no possibility of doubt in the diagnosis of the condition but that in atypical forms difficulty might arise.

We shall now consider the cysts that so closely resemble those described but to which a different origin is assigned.

#### TARRY LUTEAL CYSTS

It is unnecessary to consider the simple luteal cysts except to point out that they are of two types.

1. The corpora lutea which become cystic (3, 4).

2. The follicles which become atretic and in which the cells undergo 'luteal' change without forming a corpus luteum (10).

In either case the cellular layer becomes invaded by connective tissue and the cells become separated and altered in their morphological characteristics (Fig. 4). Some of the cysts which arise directly from the follicle have been named by Shaw granulosa luteal cysts in order to indicate that cells derived from the granulosa layer of the graafian follicle are present. These cysts are well shown in the 'luteal' cysts associated with hydatidiform mole.

Hemorrhage occurs into many of these cysts and as the blood is not (8, 9, 11, 19) absorbed and becomes old it assumes a chocolate or tarry consistency. These cysts are referred to as the tarry luteal cysts and there are thus a number of types of these cysts (Fig. 5). These are: (a) the tarry corpus luteum cysts arising by cystic change and hemorrhage into a formed corpus luteum; (aa) the tarry granulosa luteal cyst—the tarry form of the cyst described above; (b) the tarry theca luteal cyst. In some forms arising from the atretic follicle cells of the theca interna layer can be found and there is no evidence of the granulosa layer. The name thus indicates the type of cell found in the wall of the cyst.

1. The tarry corpus luteum cyst typically shows many of the characters of corpus luteum. The convolutions are marked and two types of cells are clearly differentiated—luteal and paraluteal. The later degenerative changes will be described subsequently.

2. The tarry granulosa luteal cyst. The cysts of this type that have been observed have been large. In one of the author's cases the cyst completely replaced the ovary and measured 15 centimeters in diameter while in another the cysts were bilateral and both measured 8.5 centimeters in diameter.

In the wall two types of cell may be observed. In the outer portion there are the

cells which correspond to the theca interna layer of the graafian follicle. The cells are very atypical luteal cells, having a very different appearance from the true luteal cell in any of its stages. They are usually larger than the cells of the corpus luteum of pregnancy; they are spheroidal in shape, and the protoplasm is granular with a considerable, though varying amount of blood pigment. The nucleus stains well, is spherical and eccentrically situated. The cell outline is often indistinct, and the cells themselves are separated by distinct spaces (Fig. 14). They are arranged more or less definitely in radial rows and even when few cells remain, this arrangement, which is followed by the fibrous tissue as well as the cells, may still be observed.

The granulosa cells occur only in a few parts of the wall, stain very badly, and have very indefinite cell outline. They are somewhat larger than the cells just described.

2b. The tarry theca luteal cyst differs from the former in that no cells corresponding to the granulosa cells are found in the wall. The cysts are usually small and occur in the substance of the ovary. The examples observed by the writer varied from 6 millimeters to 3.5 centimeters in diameter. They are spherical and show no convolutions suggesting the corpus luteum. They apparently develop from the follicle of the atretic type.

Microscopically, the cells resemble those described in the outer layer of the cyst previously described. The reasons for considering that the cells are theca interna cells rather than granulosa cells are: (1) The theca interna cells morphologically resemble these cells more closely than the granulosa cells, e.g., in the amount of pigment in the protoplasm. (2) Theca interna cells are more numerous than granulosa cells in the atretic forms of the follicle from which this cyst probably arises. (3) When granulosa cells occur they form a distinctive layer and are more degenerate. (4) In all cases in which granulosa cells are found in the normal or abnormal follicle a layer of cells corresponding to the theca interna cells may be found external to it. Thus, in the tarry theca interna cysts, if we regard them as granulosa cells, no cells could be found to correspond to the theca interna cells.



Fig. 1. Section of a collapsed tarry luteal cyst showing the columnar epithelial lining. The subjacent stroma containing the pseudo-xanthomatous cells is apparent. The crypts which are sometimes cut transversely are seen. Hematoxylin and Van Gieson.  $\times 140$ .

We thus have three well marked types of tarry luteal cyst. Other characteristics of these cysts may be readily observed in the routine examination of ovaries and a complete description is beyond the scope of this paper. There are probably more types than have been described—the writer has observed examples which do not correspond absolutely to these types, but whether they are merely variations or separate forms is uncertain.

Despite their different origins, they are all similar in that degeneration of the cells occurs; the walls become invaded by connective tissue which becomes hyaline, and thus the cysts may show only a few atypical luteal cells in the wall.

All of these cysts also have in common the occasional formation of an "epithelial" lining (Fig. 1). The possible origin of this lining has been frequently discussed and for our present purpose its presence is the important feature. Its cells vary from a flattened endothelium-like form to that of a bold columnar character, with basally situated nuclei (Figs. 2 and 6). When flattened or absent elsewhere, these cells are often found to be columnar in the crypts which may be seen along the surface of the cyst wall. It is thought that they appear at first in these crypts and as the cyst becomes older the epithelium becomes columnar over even the more exposed parts.

Immediately below these cells, there is an accumulation of connective tissue cells (Fig.



FIG. 2. Portion of the wall of an old tarry luteal cyst. The formation of the columnar epithelium in the depths of the cyst is well seen. The pseudo-xanthomatous cells are numerous.  $\times 140$ .

11) which may at times closely resemble the stroma seen around the endometrial glands. In this tissue there are large pigment containing cells described as pseudo-xanthomatous by some writers (Figs. 1, 2, 9, 12, and 13). Deeper among the tissue may be found the luteal cells (Fig. 11). Frequently these are not found in the areas where the epithelium occurs, but on following the cyst wall round under the microscope portions of it are found

in which there is no epithelium but in which luteal cells are in abundance, a feature which has an important bearing on the classification of any particular specimen.

Occasionally when the cells have disappeared the arrangement of the connective tissue which frequently shows the characteristic forms seen in retrogressing follicles and corpora lutea gives an indication of the original presence of luteal cells (Fig. 7). The

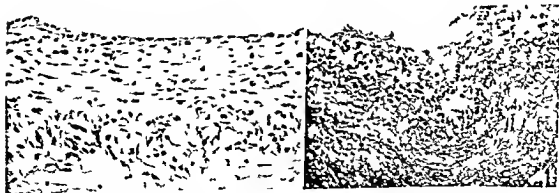


FIG. 3. Photomicrograph of portion of the wall of an old luteal cyst. Luteal cells are present with an inner fibrous layer and the internal epithelium.  $\times 180$ .

FIG. 4. Portion of the wall of an old cyst. The atypical nature of the cell is apparent. The cellular layer is invaded by connective tissue.  $\times 50$ .

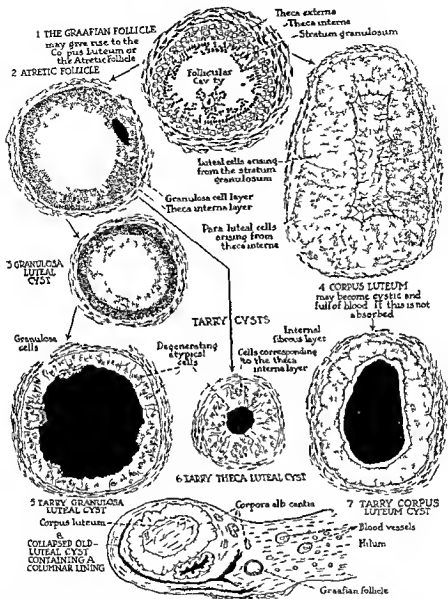


Fig 5 Diagrammatic representation of the relationships of the tarry luteal cysts 1 Graafian follicle showing the stratum granulosum and the theca interna and externa 2 The atretic follicle develops from the graafian follicle by degeneration of the granulosa cell layer and proliferation of the theca interna layer 3 The granulosa luteal cyst In some cases of atresia of the follicle the stratum granulosum proliferates instead of degenerating This occurs particularly in the cases of hydatidiform mole and also sporadically 4 The corpus luteum develops from the graafian follicle which sheds its ovum into the peritoneal cavity The luteal layer arises from the granulosa cells while the paraluteal layer develops from the theca interna

layer 5 The tarry granulosa luteal cyst This contains old blood and is the hemorrhagic counterpart of the granulosa luteal cyst The cells in its wall are degenerate and atypical 6 The tarry theca luteal cyst (Fig 4) It is derived from the atretic follicle The cells are atypical and there are no cells corresponding to the granulosa cell layer 7 The tarry corpus luteum cyst This comes from the corpus luteum cyst The cells ultimately become degenerate and separate from each other as in the other cysts Any of these cysts may develop an internal epithelial lining 8 A representation of how the cysts frequently appear in the ovary They collapse and then are only epithelium lined blood containing slits (Fig 11)





Fig. 6. Tall columnar luteal cyst showing the connective tissue lining. There is no columnar lining in this case, but a few epithelium-like cells are present. This appearance supports the view of some investigators that the columnar cells are only metaplastic in origin. Epithelium  $\times 105$ .

lumen. The luteal cells have almost disappeared being replaced by hyaline connective tissue.  $\times 105$ .

Fig. 8. A collapsed luteal cyst. The intense staining of the epithelial cells with hematoxylin is apparent. The crypts are seen cut across in section, thus giving a superficial resemblance to glands.  $\times 65$ .

connective tissue is hyaline in nature and therefore being very stable maintains for a considerable period the position and arrangement which it originally adopted. Schwarz also has remarked that it is possible to recognize luteal cysts by the arrangement of the connective tissue and possibly the presence of disintegrated nuclei and cells even in the absence of luteal cells.

#### COMPARISON OF ENDOMETRIAL WITH TARKA LUTEAL CYSTS

**Morphology.** The microscopic differentiation of endometriosis from luteal cysts is not possible. It is no doubt the experience of many pathologists who have been interested in aberrant endometrial glands to find that many blood cysts of the ovary at first considered to be endometrial have proved to be on closer inspection luteal in origin. Adhesions to neighboring structures occur with both endometrial and luteal cysts so that even this feature is of no value in differential diagnosis.

Microscopically also the resemblance may be remarkable.

1. **The epithelium.** As has been shown both types of cyst are lined with epithelium which varies from flattened cells of an endometrium like type to tall columnar cells. There is one characteristic which sometimes suggests the diagnosis the heterotopic epithelium of the luteal cysts usually takes the hematoxylin

stain much more intensely than do the structures around about (Figs. 8 and 10) while epithelium not arising in luteal cysts stains much more in uniformity with its neighboring cells.

It has been stated that the epithelial cells of the luteal cysts do not bear any resemblance to endometrial gland cells. The writer strongly disagrees with this statement. In some cases the resemblance is remarkable and requires careful examination for their differentiation.

As has been stated above the columnar cells are often first seen in the crypts in the wall of the luteal cyst and it sometimes happens that the crypts are cut transversely in section instead of longitudinally (Fig. 8). It is apparent that in appearance superficially resembling that of endometrial glands will thus be given. Earlier this appearance led the writer to accept the endometrial hypothesis as explaining the source of these structures until the examination of other and more typical portions of the cyst suggested the origin from a luteal cyst.

We thus see that the types of cells and the manner in which they form glands may render the two forms indistinguishable.

2. **The stroma.** Both types of cyst possess a subepithelial stroma. In the endometrial glands this is like the stroma of the endometrium of the uterus. In the luteal cysts it consists of round and spindle cells which



Fig 9

Fig 10

Fig 11

Fig 9 The wall of the cyst seen in Figure 8. The epithelium stroma and pseudo xanthomatous cells are seen  $\times 4$ .

Fig 10 A cyst similar to that seen in Figure 8. The

arrangement of the hyaline tissue resembling the hyalinization of a luteal body is seen  $\times 4$ .

Fig 11 The wall of a cyst showing the epithelium stroma and hyalinized luteal tissue  $\times 10$ .

contain large pigmented cells and many dilated vessels.

Again it is stated that this stroma does not in any way resemble the stroma of aberrant endometrial glands. This statement certainly does not apply to the less typical examples of either condition for the two may approach one another till they are indistinguishable. Endometrial glands may show many variations from the normal appearance while the subepithelial structures of the luteal cysts may in some parts present an extraordinary resemblance to endometrial stroma. This is well shown in Figures 15, 16 and 17.

3. *Large phagocytic cells* These cells described as "pseudo xanthomatous" occur in cysts of both types. They are larger than luteal cells, contain many pigmented granules in their cytoplasm and occur in greater numbers where the epithelium is best developed (Figs 1, 2, 9 and 13).

4. *The surrounding tissue* In the luteal cysts it is the immediately surrounding tissue that gives the diagnosis even should luteal cells be absent (Fig 10). The fibrous tissue is arranged in a characteristic manner between the cells; it becomes hyaline, and this formation remains even after the cells have disappeared.

*Physiology* Structural alterations occur during the different stages of the menstrual cycle.

In this particular, also the cysts of both types are similar. Bleeding occurs into the endometrial cysts at menstruation and hem-

orrhage also takes place into luteal cysts during or immediately after menstruation.

It is clear in some reported cases that an ovarian cyst has been considered to be endometrial merely because the bleeding into a cyst bears some not necessarily exact relation to the menstrual period.

In a general way therefore, we are not assisted in our differential diagnosis by the physiological behavior of the cyst.

#### THE RELATIONSHIP TO ASSOCIATED ABERRANT ENDOMETRIUM

Endometriosis is frequently multiple and the presence of endometrial glands in other organs has been considered presumptive evidence that the tissue in the ovary is also endometrial.

It has recently been suggested however that an important factor in the etiology of endometriosis is the presence of abnormal possibly excess, hormone arising in the ovary. The hormone is probably of the luteal or follicular type. In the hemorrhagic luteal cysts under discussion there is certainly excess luteal tissue and probably excess and abnormal hormone. This has been demonstrated by the hyperplastic condition of the endometrium which has been present in some cases. Meyer suggests that such a hormone may be responsible not only for hyperplasia of the normal endometrium, but also possibly the development of endometrium in abnormal situations. What value if any, may be placed on these hypotheses is beyond the range of this discussion, but the important observation is



FIG. 6. Part of a collapsed tarry luteal cyst showing the connective tissue lining. There is no columnar lining in this case but a few endometrium like cells are present. This appearance supports the view of some investigators that the columnar cells are only metaplasia from endometrium  $\times 100$ .

FIG. 7. The wall of a tarry luteal cyst with an epithelial

lining. The luteal cells have almost disappeared beneath the hyaline fibrinosis.  $\times 100$ .

FIG. 8. A collapsed tarry luteal cyst. The intense staining of the epithelial cells with hematoxylin is apparent. The cysts are seen cut across in section thus giving a superficial resemblance to glands.  $\times 125$ .

connective tissue is hyaline in nature and therefore being very stable maintains for a considerable period the position and arrangement which it originally adopted. Schwarz also has remarked that it is possible to recognize luteal cysts by the arrangement of the connective tissue and possibly the presence of disintegrated nuclei and cells even in the absence of luteal cells.

#### COMPARISON OF ENDOMETRIAL WITH TARRY LUTEAL CYSTS

**Morphology.** The microscopic differentiation of endometriosis from tarry luteal cysts is not possible. It is no doubt the experience of many pathologists who have been interested in aberrant endometrial glands to find that many blood cysts of the ovary at first considered to be endometrial have proved to be on closer inspection luteal in origin. Adhesions to neighboring structures occur with both endometrial and luteal cysts so that even this feature is of no value in differential diagnosis.

Microscopically also the resemblance may be remarkable.

1. *The epithelium.* As has been shown both types of cyst are lined with epithelium which varies from flattened cells of an endometrium like type to tall columnar cells. There is one characteristic which sometimes suggests the diagnosis the heterotopic epithelium of the luteal cysts usually takes the hematoxylin

stain much more intensely than do the structures around about (Figs. 8 and 10) while epithelium not arising in luteal cysts stains much more in uniformity with its neighboring cells.

It has been stated that the epithelial cells of the tarry luteal cysts do not bear any resemblance to endometrial gland cells. The writer strongly disagrees with this statement. In some cases the resemblance is remarkable and requires careful examination for their differentiation.

As has been stated above the columnar cells are often first seen in the crypts in the wall of the luteal cyst and it sometimes happens that these crypts are cut transversely in section instead of longitudinally (Fig. 8). It is apparent that an appearance superficially resembling that of endometrial glands will thus be given. Later this appearance led the writer to accept the endometrial hypothesis as explaining the source of these structures until the examination of other and more typical portions of the cyst suggested the origin from a luteal cyst.

We thus see that the types of cells and the manner in which they form glands may render the two forms indistinguishable.

2. *The stroma.* Both types of cyst possess a subepithelial stroma. In the endometrial glands this is like the stroma of the endometrium of the uterus. In the luteal cysts it consists of round and spindle cells which

This occurrence again shows the exceedingly close resemblance that these cysts bear to each other. In the case of the tarry luteal cyst, the reaction of the peritoneum is due to the presence of the luteal cells (Figs 18 and 19) and heterotopic epithelium derived from the cyst. The epithelium sometimes forms small spaces in the peritoneum, containing tarry material, similar to that of the original cyst and macroscopically, these may be seen projecting from the peritoneum as small bluish black nodules or cysts. In the case observed by the writer some of the cysts contained only yellowish fluid and one of the cysts was of a large size—3 centimeters in diameter. The resemblance of these structures to secondary endometrial growths is immediately apparent and the need for careful differentiation is obvious.

It will be seen from the foregoing, as also will be shown by a careful routine study of ovaries that tarry luteal cysts and endometrial cysts have many features in common.

#### SUMMARY

1 Endometrial cysts of the ovary and tarry luteal cysts possess many features in common.

2 They are indistinguishable macroscopically.

3 Microscopically, diagnosis requires careful study, since (1) the epithelium in both cases may be similar, (2) the subjacent stroma in the luteal cyst may closely resemble that of endometrial glands, (3) gland spaces may be seen in both, (4) pseudo xanthomatous cells occur in both, (5) the characteristic structure of the luteal cyst may not be apparent in all parts of the wall so that a thorough study in doubtful cases is essential.

4 Their similarity extends to their physiology and complications.

5 Tarry luteal cysts sometimes rupture into the peritoneal cavity, thus producing secondary blood cysts and a severe inflammatory reaction similar to that produced by "endometrial" cysts.

#### CONCLUSIONS

The writer's experience suggests that the endometrial diagnosis has been made too frequently and on insufficient evidence or erroneous interpretation. The frequency with which he is able to demonstrate a luteal nature for cysts of this kind suggests that many of those recorded are possibly luteal in origin.

#### BIBLIOGRAPHY

- 1 BRAKENAM, O. Beitrag zur Klinik und Pathologie der Teerzysten des Eierstocks. Arch f Gynaek 1927 cxxx 632
- 2 CULLEN, T. S. The distribution of adenomyomas containing uterine mucosa. Arch Surg 1920 1 215
- 3 FRAENKEL, C. Ueber Corpus Luteum Cysten. Arch f Gynaek 1894 cxviii 1
- 4 Idem. Ueber Corpus Luteum Cysten. Arch f Gynaek 1898 lxxv 511
- 5 FRAENKEL, L. Der Bau der Corpus Luteum Cysten. Arch f Gynaek 1898 lvi 355
- 6 HIFED, S. B. An investigation of the abnormal development of endometrial tissue within the female pelvis. J Obst & Gynec 1923 xxvii 649
- 7 KING, E. S. J. and FINDLEY, J. A clinical and pathological study of endometriosis. J Coll Surg Australasia 1929 1 303
- 8 LEBROS, N. C. Ueber Corpus Luteum Blutungen. Arch f Gynaek 1923 cxviii 194
- 9 MATHES, P. Zur Pathologie des Corpus Luteum. Arch f Gynaek 1923 cxix 163
- 10 NOVAK, E. and TELINDE, R. W. The pathological anatomy of the corpus luteum. Bull Johns Hopkins Hosp, 1923 cxciv, 289
- 11 OETTINGER, K. VON. Zur Aetiologie der Luteincysten. Ztschr f Gynaek 1922 xiv 548
- 12 PICK, L. Ueber Neubildung am Genitale bei 7 wittern, nebst Beiträgen zur Lehre von den Adenomen des Hodens und Eierstocks. Arch f Gynaek 1903 lxxvi 191
- 13 RUSSELL, W. W. Aberrant portions of müllerian duct in ovary. Bull Johns Hopkins Hosp 1899 x 8
- 14 SAMSON, J. A. Perforating hemorrhagic (chocolate) cysts of the ovary. Arch Surg 1921 iii 245
- 15 Idem. Metastatic endometriosis due to the menstrual dissemination of endometrial tissue into the venous circulation. Am J Path 1927 iii 93
- 16 Idem. Peritoneal endometriosis due to the menstrual dissemination of endometrial tissue into the peritoneal cavity. Am J Obst & Gynec 19 7 xiv 422
- 17 SCHWARTZ, E. Cysts of the corpus luteum. Amer J Obst 1919 lxxix 516
- 18 SHAW, W. Some pathological forms of the corpus luteum. J Obst & Gynec 1927 xxxiv 300
- 19 STUEBLER, F. and HAEUBER, A. Die heterotopie endometriale Epithelwucherung im weiblichen Genitalapparat insbesondere im Ovarium. Arch f Gynaek 1925 cxvii 305
- 20 WINSTINE, F. Decidua of pregnancy in adenoma endometrioides ovarii. Arch Surg 1928 viii 772

Fig. 12



Fig. 12

Fig. 13

Fig. 14

Fig. 12. A portion of the wall of the cyst shown in Figure 10.  $\times 110$ .

Fig. 13. The wall of a tarry luteal cyst similar to that shown in Figures 1 and 10.  $\times 110$ .

Fig. 14. A high power view of luteal cells seen in the walls of these cysts. The cells have an indefinite outline

eccentric nucleus and granular vacuolated protoplasm.  $\times 600$ .

Fig. 15. Portion of the wall of a cyst from the same ovary from which the cyst seen in Figure 8 was taken. Another portion of the cyst was obviously luteal. The resemblance to endometrial tissue is considerable.  $\times 110$ .

that endometriosis may be associated with other disease of the ovary particularly luteal abnormalities. In any case of multiple endometriosis therefore the too carefree conclusion that the blood cysts of the ovary must be endometrial in nature is undesirable.

#### COMPLICATIONS

For many years the extraordinary reactionary fibrosis following the rupture of endo-

metrial cysts into the peritoneum caused much discussion. It was decided at first that the old tarry or chocolate material must have some special irritating power. Later it was shown that it was small pieces of endometrial tissue growing in the peritoneum which caused the intense reaction. That a similar result may arise from the rupture of tarry luteal cysts has been overlooked except by the two workers previously mentioned.



Fig. 16

Fig. 17

Fig. 18

Fig. 19

Fig. 16. Subepithelial glands from the same cyst as that seen in Figure 15.  $\times 100$ .

Fig. 17. Portion of the wall of a luteal cyst. Some portions were typical. No other glands of this nature were found in the ovary. The resemblance of the stroma to that of endometrial glands is remarkable.  $\times 100$ .

Fig. 18. Section of peritoneum from an area of fibrosis and thickening which followed on the rupture of a tarry luteal cyst.  $\times 60$ .

Fig. 19. Section of a nodule of the peritoneum showing the luteal cells which are responsible apparently for the inflammatory reaction and fibrosis.  $\times 225$ .

appeared older than the perforation could be discovered. In some of these cases, although gastric contents were found lying remote from the region of the stomach and the perforation was left unsutured because already covered over or sealed, the patients went on to a recovery.

There can be little doubt, therefore, that the speedy spontaneous recovery which occurs after some perforations is not due to preformed adhesions but to a change which follows rather than antedates the rupture. This change consists of the early spontaneous sealing or plugging of the hole. As a consequence of obturation of the perforation, instead of a continuous leakage such as occurs in the classical case when left unsutured there results in the *formes frustes* type a trifling or at most a limited escape of gastric or duodenal content. The peritoneum is readily able to cope with a small amount of foreign liquid which is relatively sterile and therefore but slight peritoneal disturbance ensues. The various methods and agencies by which the perforation becomes spontaneously occluded have been mentioned in previous papers (Singer, and Vaughan and Singer).

#### INCIDENCE

It is universally taught even by most of those who have written upon the subject that the occurrence of the *formes frustes* type is uncommon as compared with the incidence of classical cases. We held to this teaching until we learned to recognize the clinical picture of the mild cases when we were struck by their relative frequency. Most of the patients suffering from this condition felt fairly well at the time of admission to the hospital and entered in order to convalesce or on account of the persistency of a mild pain. One patient entered because he was curious to learn the diagnosis. The fact that more than two thirds of the *formes frustes* cases were assigned by the admitting physician to the medical service indicates the mildness of the symptoms at the time of entrance, for it is the policy in our examining room to send a patient to a surgical ward whenever the suspicion of an "acute abdomen" is entertained. We were able to diagnose these cases in spite of the mild picture they presented by a painstaking analysis of



Fig 1. Case 1. Pneumoperitoneum from perforated peptic ulcer 4 days after rupture and a few hours after admission to hospital. No operation. Recovery.

the history with special reference to the presence of previous ulcer distress and the details of onset of the recent acute illness.

In order to obtain some idea of the incidence of the *formes frustes* type we canvassed as many wards of the Cook County Hospital as we could through the courtesy of other members of the attending staff, during the months of January, February and March of this year. Undoubtedly, we failed to uncover some of the *formes frustes* cases but nevertheless succeeded in collecting data on 14 cases. During the same period of time only 12 cases of classical perforated ulcer were admitted to the hospital. We are quite convinced that this number represents about all the cases of classical perforation that entered during the 3 months since practically all our "acute abdomens" with grave symptoms have been either operated upon or autopsied. It would seem from our statistics that the milder cases are even more frequent than the classical ones, an observation which appears rather incredible.

## III "FORMES FRUSTES" TYPE OF PERFORATED PEPTIC ULCER

JUDGING from textbooks and systems of surgery perforation of a peptic ulcer into the free abdominal cavity is considered practically always fatal unless the hole is closed surgically. The current impression of the clinical picture and natural course of the disease is as follows. The patient is seized by a violent intolerable epigastric pain which frequently results in collapse. The initial pain and accompanying symptoms may or may not be followed by a temporary remission the so-called period of repose. In either event evidences of diffuse peritonitis soon appear and rapidly progress. Without operation death ensues within a few days in all but a small proportion of the cases—generally quoted as less than 5 per cent. Of the patients who recover from the diffuse peritonitis a certain number develop intraperitoneal abscesses which may eventually require surgical drainage. In addition to the group presenting the classical type of perforation just described there is a group of cases in which the overwhelming pain at the onset is rapidly followed by progressive collapse and death within a few hours. The clinical picture of this fulminant type of perforation is likewise well known to the general profession. There is however a third variety which heretofore has attracted but little attention and has therefore failed to receive universal recognition. Such cases are referred to in the German literature as *gedeckte Perforation* (Schnitzler) and in the French literature as *perforation fermée et isolée* (Delagenière) while American and English authors have chosen the term *subacute perforation* (Lund Moynihan). This type of perforation although ushered in by symptoms of a perforative peritonitis fails to develop evidences of diffusely progressive peritonitis as in the classical form but instead produces rather mild symptoms which quickly

abate. In order to emphasize the essential clinical difference between the classical and the mild perforation which is actually acute rather than subacute we have chosen the term *formes frustes* in preference to the other previously suggested names.

## MECHANISM

What determines whether a perforation should result in a classical clinical picture or in mild and transient symptoms? When a perforation is followed by spontaneous recovery it is generally assumed that rupture occurred into a preformed sac or into adhesions. This assumption which is based upon inference appears in the light of the knowledge gained from surgical observations to be contrary to fact. The available evidence indicates almost indubitably that perigastric adhesions follow rather than precede the perforation. The indirect testimony in support of this contention entailing as it does polemic discussion may be omitted since direct evidence is readily available.

In a number of *formes frustes* cases we have succeeded with the aid of the fluoroscope in demonstrating free intraperitoneal air which could be made to shift to all parts of the abdomen on change of the patient's position. In most of these cases for one reason or another operation was not performed but the antecedent history of ulcer, the acute onset with symptoms and signs of upper abdominal peritonitis, the subsequent barium meal examination and the clinical course rendered it clear that a perforated peptic ulcer was the cause of the pneumoperitonium. These patients recovered spontaneously in spite of their free perforations. Even more convincing than the demonstration of free air is the fact that in a number of cases in which operation was performed no perigastric sac or adhesions which

occurs that at the time the patient comes under observation the pain is felt exclusively in the right lower quadrant. This shifting of the pain site is due to gravitation of the escaped fluid into the right iliac fossa. Unless specific inquiry is made no history of initial upper abdominal pain may be elicited. It is in this type of case particularly that the mistaken diagnosis of appendicitis is so frequently made. When the inflammation extends to the subphrenic region on the right side, the pain may be experienced in the right upper or lateral abdominal region. Hiccough may be the chief subjective manifestation of subphrenic localization. It tends to be troublesome and incessant and may constitute the patient's presenting complaint. The fever is usually subfebrile in degree, rarely reaching above 100 degrees F, except in the more severe cases. The leucocyte count ranges between 10,000 and 20,000 with a relative increase of the polymorphonuclear leucocytes.

Physical examination during the stage of peritoneal reaction discloses indications of intra abdominal inflammation which as a rule are more or less diffuse. Tenderness is elicited in the upper abdominal region at the site of and adjacent to, the region of perforation and frequently in the right lower quadrant also. In those cases which are mistaken for appendicitis the error results from neglect to palpate the entire abdomen, to percuss the liver dulness and to listen to the peristaltic sounds, for in all instances so far as our experience goes the tenderness when present over McBurney's point is not restricted to this one site but can be elicited in other portions of the abdomen also. The rigidity in this second stage is mild as compared with the board like resistance encountered shortly after the acute onset. The muscular defense which is noted upon palpation corresponds roughly to the distribution of the tenderness. Peristaltic sounds are usually much diminished. Tympany is seldom pronounced early but some slight or moderate distention usually appears by the second day. If the escaped fluid reaches the subphrenic space, a peritoneal rub may be heard over the hepatic region synchronous with respiration. This friction rub was noted in two of our recent cases and in



Fig 3 Case 7 Three days later than Figure 1

the first of the two was the means, together with the hiccough, of attracting our attention to the possibility of a perforated ulcer. Obliteration of liver dulness is only rarely demonstrated in the *formes frustes* cases presumably because leakage is only slight.

#### X RAY EXAMINATION

Fluoroscopic examination undertaken immediately upon entrance to the hospital shows in only a part of the cases the presence of free intraperitoneal air and only occasionally is the amount of escaped gas as large as in the classical case. As a rule, only a thin zone of shifting radiolucence is seen. In some instances of *formes frustes* perforations we observed limitation of motion of the right diaphragm which led us to consider this phenomenon an indirect sign of upper abdominal peritonitis. Occasionally we found air in the right upper abdominal quadrant but were unable to differentiate clearly without a





Fig. 2. Case 1. Roentgenogram taken 24 hours later than Figure 1.

The period over which this clinical study was made is obviously too short to permit drawing final conclusions and we merely submit the figures for what they are worth. Nevertheless we are prepared to state confidently that the *formes frustes* perforation is not of uncommon occurrence and that it is frequently overlooked.

#### SYMPTOMATOLOGY

The onset of perforation is preceded in over half of the cases by periodic attacks of chronic ulcer distress usually for a period of one or more years. In the majority of the patients for one to several days prior to the actual perforation prodromal symptoms consisting of pain, vomiting and epigastric tenderness are noted. The pain is more severe of different character and less responsive to alkalis than the ordinary ulcer distress. Vomiting is more persistent than in the usual case and often fails to relieve the pain. The patient is aware of a point of tenderness in the epigastrium, excited by even slight touch. In

practically all instances, however, and not infrequently without even the slightest previous abdominal discomfort the onset is extremely abrupt and sudden. In fact, up to this point it is practically identical in all respects with the onset of perforation in the typical case except perhaps in intensity. The pain which is located usually in the epigastrium is violent in character and causes the patient to double up and writhe about in agony. As a rule the pain is not quite so excruciating as in the classical case. The prostration which accompanies the pain is not so overwhelming or so striking in the *formes frustes* type, nevertheless the picture the patient presents is usually a quite dramatic one. If the abdomen is examined within the first few hours or so after perforation the same board like rigidity and upper abdominal tenderness will be elicited as in the classical case.

Within a few hours after the occurrence of the perforation that is, from 2 to 10 hours the initial symptoms may practically subside leaving the patient in a state of comparative comfort. If the patient is seen during this quiescent period the presence of an abdominal catastrophe may not be suspected. Frequently however evidences of peritonitis appear and the subsequent course is dependent on the amount and character of the escaped gastric contents. In those cases in which only a small quantity of relatively sterile duodenal fluid has escaped and merely a mild local peritoneal reaction has been excited little discomfort may be felt and this but for a short period of time. Some of the patients with trifling leakage feel quite well within a few hours after onset and unless otherwise instructed will resume their normal activities. Extravasation of a considerable quantity of food and secretion from the stomach however will produce a more or less diffuse peritonitis with a commensurate increase of the symptoms. In these cases pain of a rather severe nature associated at times with vomiting will persist as a rule for several days following perforation. The pain generally is felt in the epigastrium much more frequently to the right than to the left of the midline.

In cases in which the pain was originally perceived in the upper abdomen it frequently

occurrence of a perforation with spontaneous closure. Extravasated gastric contents are readily disseminated over the entire abdomen and organization of the exudate can produce adhesions which may not cause trouble until years after the symptoms of a *formes frustes* perforation have been forgotten.

By discarding the textbook symptomatology of perforated ulcer and recognizing the *formes frustes* type, it is a simple matter to explain the spontaneous recovery of patients with a perforated viscus. It not infrequently happens that appendectomy is performed in the presence of an undiscovered perforated ulcer. The amputated appendix discloses healthy subserous structures and a peripendiceal inflammation which is part of the peritonitis caused by the gastroduodenal perforation. A number of these patients through the kindness of nature recover from the perforation and operation both and subsequently consult an internist for ulcer complaints. Not infrequently patients with diffuse peritonitis without any demonstrable point of origin are operated upon, the wound closed, or drainage applied without the site of origin being identified. Recently a patient was admitted to the hospital and operated upon for perforated ulcer but no perforation was found. From the history and subsequent course of events, the X-ray evidence of ulcer and perigastric adhesions, and the examination of the excised normal appendix, it seems probable that the peritonitis resulted from a perforated ulcer which became so completely sealed over by fibrin that the perforation escaped discovery at operation. The patient recovered completely after a rather stormy convalescence so that the question as to the source of the peritonitis is now solely an academic one.

This conception of spontaneous plugging of the perforation furnishes a means of reconciling the extreme discrepancies among statistical reports from various clinics on the subject of perforated ulcer. If surgical intervention is instituted only in those cases in which the symptoms of peritonitis are severe and progressive, the mortality in the cases seen after the first 24 hours will be quite high. This explains why Kuemmel, of Hamburg, was unable to save a single patient with perforated



Fig. 5. Case 1. Six days after Figure 1. Pneumoperitoneum has disappeared. Patient free from symptoms. Barium study 10 days later revealed duodenal ulcer.

ulcer of more than 24 hours duration. By declining to operate upon patients with widespread peritonitis and classifying them as inoperable or moribund, a surgeon can easily maintain a low operative mortality rate and still include in his series a considerable number of late cases. These late cases, however, would represent examples of the *formes frustes* type which probably would have gone on to recovery without operative intervention. When judging such statistics, therefore, it is important to know not only the time which elapses between the perforation and the operation but also to have complete knowledge of the extent and severity of the peritonitis at the time the surgeon intervenes.



FIG. 4. Case 1. Four days after Figure 1.

barium enema between intracolonic and extracolonic gas. We have refrained from subjecting these patients with suspected perforations to X-ray examination with barium until from 7 to 10 days after the onset of the acute attack. In most of the instances we have succeeded at the end of this time in demonstrating an ulcer niche of the stomach or a deformity of the duodenum.

#### CLINICAL COURSE

The course of the average *formes frustes* case is surprisingly calm. Most patients feel so well after the second or third day that it is difficult to persuade them to remain hospitalized. In a few cases, especially those with subphrenic involvement or a little more extravasation than the average, some fever is likely to persist 2 to 3 weeks before complete recovery ensues.

#### TREATMENT

If recognized within the first 24 hours a patient with a perforation is as a rule operated

upon immediately regardless of the severity or mildness of the symptoms. In the event that the patient is not seen until the second day, i.e., between the twenty-fourth and forty-eighth hours after perforation, surgical treatment is practiced unless the signs and symptoms point indubitably to a spontaneous closure and trifling leakage. If there is any question as to the perforation being sealed, operation is insisted upon. After the first 24 hours it generally is not difficult to decide whether the perforation is closed or not.

#### COMMENT

The recognition of the *formes frustes* perforation has aided us greatly in diagnosis, for since familiarizing ourselves with the clinical picture we have succeeded in recognizing a number of cases which we formerly should have misdiagnosed. These cases were erroneously considered as instances of acute gastritis, acute cholecystitis, acute pancreatitis, acute appendicitis, diaphragmatic pleurisy, central or abortive pneumonia, angina pectoris, coronary thrombosis, lead colic, diabetic crises, mesenteric thrombosis, and intestinal intermittent claudication. We do not wish to enter into a detailed discussion of the differential diagnosis at this time but merely desire to emphasize that the mistakes which are commonly made are the result usually of failure to consider or lack of familiarity with this mild type of perforated ulcer.

The view presented in regard to *formes frustes* perforations is not only of assistance in the diagnosis of hitherto obscure cases but also throws light upon the origin of a number of puzzling lesions. The assumption that these mild cases are of rather frequent occurrence explains some of the so-called cryptogenic intra-abdominal abscesses, especially the subphrenic and hepatic ones. A short while ago a patient was admitted to the hospital with symptoms and findings of a liver abscess for which no etiology was discovered even at postmortem examination until the history that the patient previously had had symptoms of a ruptured ulcer led to the search for evidence of a previous perforation and finally revealed it. Intra-abdominal adhesions not only local but also distant can be due to the

occurrence of a perforation with spontaneous closure. Extravasated gastric contents are readily disseminated over the entire abdomen and organization of the exudate can produce adhesions which may not cause trouble until years after the symptoms of a *formes frustes* perforation have been forgotten.

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Fig 6 Case 2 Pneumoperitoneum from perforated peptic ulcer 36 hours after perforation when patient entered hospital and was submitted to X ray examination. Later examination with barium showed duodenal deformity. Recovery without operation.

#### SUMMARY

We have outlined a syndrome which permits the diagnosis of perforated peptic ulcers with only trifling leakage. The diagnosis is easy when spontaneous pneumoperitoneum is present and a little more difficult but still usually possible when free air is absent.

Many of these *formes frustes* cases heal spontaneously without operation but our experience with them is still too limited at the present time to justify positive conclusions as to operative indications.

What we wish to stress most is the surprising frequency of this condition and the use of the X ray as an adjuvant in its diagnosis.

#### REFERENCES

1. DELAGENIERE M. Ulcère de la petite courbure de l'estomac. Congr de Chir. Paris 1920 *ixix* 140-159.
2. KUEMMELL H. Ueber Indikationen zur chirurgischen und internen Behandlung der Magererkrankungen. *Perl med Wchnschr* 1912 *xliv* 141.
3. LUND F B. Subacute perforation of the stomach with report of three cases. *Boston M & S J* 1903 *cli* 516-518.
4. MOYNIHAN B G A. Subacute perforation of the stomach and duodenum. *Ann Surg* 190 *xl* 223-237.
5. SCHNITZLER J. Ueber gedeckte Magenperforationen und ueber die Entleerung der penetrierenden Magengeschwueere. *Med Klin* 1912 *i* 038-042.
6. SINGER H A. Walled off and free perforation of peptic ulcer. *M Clin N Am* 1921 *ii* 63-77.
7. VAUGHAN R T and SINGER H A. The value of radiology in the diagnosis of perforated peptic ulcer. *Surg Gynec & Obst* 1929 *xliv* 593-599.

# PRIMARY CARCINOMA OF THE URETER

## REPORT OF A CASE AND A REVIEW OF THE LITERATURE

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UNUSUAL lesions often arouse the most interest and speculation. It is with this in mind that we are presenting the history of a case that proved to be a primary epithelial tumor of the ureter.

### HISTORICAL

Carcinoma originating in the ureter is a rare condition. Raver, in 1841, described the first case. The earliest report in the English literature did not appear until 43 years later (Davy). As late as 1926 Blatt could collect only 40 cases. Reviewing the available literature we have been able to find a few more reports so that our survey brings the total number of cases up to 49. To this we wish to add our case.

Mrs. M. M. History, No. 70889, a 48-year-old negro housewife, was admitted to the Presbyterian Hospital February 4, 1938. Her chief complaint was pain in the left flank and left costovertebral angle of 6 weeks' duration. The family history was irrelevant. Patient had been married 32 years, had had 6 children and two miscarriages. Her general health had always been good. Eight years previously she had had an attack of gall stone disease manifested by right upper quadrant pain. For the past years she had experienced dyspnea on exertion. Symptoms referable to no other system were recalled by patient.

Six weeks before admission to the hospital she first noticed that she was becoming gradually weaker. About the same time she began to suffer from pain in the left flank and left costovertebral angle. At that time she went to bed, remaining there until her entrance to the hospital. The pain was constant from the onset except when relieved by medication. She felt feverish at intervals and had several drenching night sweats. Vomiting occurred on only three occasions, each time after taking medicine. Her bowels had been constipated, requiring enemata. Nocturia proved a distressing feature from the beginning of her illness. Burning micturition was present for the 2 days prior to her visit to the hospital. The patient was certain that her abdomen had increased in size. No loss of weight could be ascertained.

Physical examination disclosed a well developed obese negroess, somewhat prostrated, feeble and exhausted. Temperature was 101.2 degrees, pulse

110, respiration, 32. The skin was warm and dry. The tongue had a thick white coat. Many teeth were missing and those still present were carious. Lymph nodes showed no general enlargement. Examination of the lungs revealed dullness at the left base posteriorly, flatness in left midaxillary line, loud tubular breathing above and slightly posterior to the area of flatness. The right lung was clear and resonant. The heart was overacting, rate rapid, apex not felt in prone position. On percussion the apex was 16 centimeters to left of midline in fifth interspace. No thrills or murmurs and no arrhythmia were found. The sounds were loud and snapping. The second aortic sound was stronger than the second pulmonary. Blood pressure was 122-65. The abdomen was protuberant and the wall flabby. There was no evidence of fluid. Tenderness was present in the left flank, left costovertebral angle and to lesser degree in the left upper quadrant. A large, hard, immovable mass could be palpated in the left upper quadrant. The liver and spleen were not felt. Rectal and pelvic examinations disclosed a large, round, smooth mass in the cul de sac.

Cystoscopic examination showed the floor of the bladder to be pushed up by a mass. This was interpreted as being an ovarian cyst.

X-ray examination of the abdomen gave evidence suggestive of stones in the left kidney. X-ray examination of the chest revealed a small amount of fluid at the left base. The right diaphragm had the appearance of a recent pleurisy but nothing was seen which was suggestive of metastases.

Laboratory findings: Phenolsulphonphthalein test yielded 5 per cent excretion in two hours. Blood urea was 0.8 gram per liter, blood carbon dioxide was 29 volumes per cent. Red blood cells, 2,400,000; haemoglobin, 55 per cent; white blood cells, 29,000. Differential count showed polymorphonuclear neutrophils, 93 per cent; lymphocytes, 6 per cent; endothelialocytes, 1 per cent. Examination of the urine gave a specific gravity 1.010, reaction, alkaline, sugar none, albumin heavy trace. Microscopic examination revealed the presence of pus.

Course: An exploratory laparotomy was performed one week after admission and a large dermoid cyst of the left ovary was discovered. Removal of this mass was attempted but had to be abandoned because of the condition of the patient. The cyst, however, was opened and its contents evacuated to relieve pressure on the bladder and ureter. From the time of her admission and throughout the course of her illness the patient had a septic temperature varying between 99 degrees and 101 degrees F. She grew progressively weaker and died 31 days after

TABLE I—RÉSUMÉ OF THE FORTY NINE CASES COLLECTED FROM THE LITERATURE

Case and reference number	Sex	Age	Symptoms and signs	Association with calculus	Final diagnosis	Treatment and course	Pathology
1 (36)	F	55	Abdominal pain at irregular attacks of hematuria. No other symptoms or duration given	No			Autopsy: small pedunculated tumor nodules in the upper kidney calyces bladder. Metastases in mesenteric nodes and liver. No microscopic examination reported.
2 (49)	F	41	Pain in right lumbar region and abdomen. Tumor palpated in right flank	No		No operation. Patient died 41 days after admission	Autopsy: tumor upper 1/3 cm. right ureter. Invasion of renal pelvis. Hydro-nephrosis of right kidney. Metastases in rectum retroperitoneal and desmoplastic. Microscopic diagnosis: medullary carcinoma of right ureter.
3 (10)	M	53	Pain in left side and penis for 3 yr. Worse for 7 mo prior to admission. Hematuria intermittent. Passed calculus 1 yr before. Tumor palpated in left flank for 2 yr. Physical examination shows a fluctuant nodule, immovable tumor in left abdomen	Yes	Cyst involving left kidney and ureter	(1) Nephrectomy (2) nephrectomy. Died 2 mo later	6 cm. specimen hydro-nephrosis left. Autopsy: 1 cm. lower 1/3 of left ureter. Hydro-ureter. Calculus at site of ureter. Invasion of lower 1/3 to base of bladder and perforation into rectum. Metastases in lymph nodes and liver. Microscopic diagnosis: encephaloid carcinoma of left ureter.
4 (47)	M	68	Hematuria pain across loins nausea anorexia and weight loss—4 mo duration	No		No operation. Patient died about 7 wk after admission	Autopsy: tumor lower 1/3 of left ureter. Hydro-ureter and hydronephrosis. Left metastases in left lumbar nodes and lung. Microscopic diagnosis: villous carcinoma of left ureter.
5 (38)	M	46	Fullness in right side of abdomen increasing gradually and painlessly for 1 yr. Hematuria. Physical examination: weak and emaciated man. Fluctuating swelling in lower abdomen. Urine negative	No	Malignant disease suspected. Location not given	Fluctuant tumor tapped twice. No operation	Autopsy: tumor lower 1/3 of right ureter. Invasion of bladder wall, both sides of ureter. Metastases in abdominal nodes, liver and lungs. Hydro-ureter and hydronephrosis. Microscopic examination: squamous cell carcinoma of right ureter.
6 (20)	M		No history given other than that patient died of a disease of pneumonia	No		No operation. Died of pneumonia	Autopsy: tumor lower part of right ureter, apparently arising from a diverticulum. Microscopic diagnosis: epithelioma of left ureter.
7 (16)	F	50	Increasing pain in right lumbar region radiating to hip. Tumor in abdomen which seemed connected with the tumor	No	Osteosarcoma	Died	Autopsy: microscopic diagnosis: medullary carcinoma of right ureter.
8 (15)	F	80	Abdominal pain radiating to thigh. Constipation. Anorexia. Hematuria. Tumor size of child's head in right side of abdomen	No	Testative diagnosis: hydronephrosis	No operation. Patient died	Autopsy: tumor bladder. Tumor part of right ureter. Metastases in pelvis. Metastases in lymph nodes. Microscopic diagnosis: carcinoma of right ureter.
9 (27)	F	66	No history given	No	Not mentioned in report	Not mentioned in report	Autopsy: tumor lower 1/3 of right ureter. Invasion of bladder and peritoneum. Microscopic diagnosis: adenocarcinoma of right ureter with peritoneal invasion.

TABLE I—Continued

Case and reference number	Sex	Age	Symptoms and signs	Association with calculus	Clinical diagnosis	Treatment and course	Pathology
10 (73)	M	67	Hematuria of 6 mo duration. Polyuria and urgency of recent origin. Acute pain in rt. kidney region, often accompanied by pain in rt. hip. Physical examination: patient looked anemic and had an icteric tint to his skin; in lungs otherwise unimportant.	No	Malignant tumor of rt. ureteral orifice.	Cystoscopy negative 6 mo previously but on last examination a tumor found in region of rt. ureteral orifice. Suprapubic cystostomy and fulguration of tumor mass. Patient died 25 days later.	Autopsy: pigeon-egg size tumor of rt. ureteral orifice. Two small tumor nodules in rt. wall of bladder. Metastases in rt. kidney and lung. Extension of tumor into the prostate. Hydronephrosis rt. Microscopic diagnosis: carcinoma of the rt. ureter.
11 (34)	M	41	Pain in l. kidney region accentuated during activity and relieved by rest. Attacks accompanied by hematuria—5 yr duration. 4 yr before admission to hospital fell and injured left hip and thigh. Immediately after suffered from radiating pain in l. kidney region. Associated with fever. Tumor size of a man's fist palpated in left flank.	No	Tumor of left kidney.	Cystoscopy cystitis present. L. ureteral opening the site of tumor. Nephro-ureterectomy. Patient died 31 days after operation.	Surgical specimen: left kidney not enlarged but pelvis dilated. Hydronephrosis. Multiple papillary growths in pelvis and ureter down to hilum.
12 (43)	M	62	Intermittent pain to back with recurrent hematuria of 6 mo duration. Small palpable lump to the left of umbilicus.	No	None reported.	Not reported.	Autopsy: tumor of l. ureter. Hydronephrosis and hydronephrosis. Metastases in retroperitoneal glands. Microscopic diagnosis: cells of transitional epithelium.
13 (4)	F	60	Very severe intermittent pain in rt. side of abdomen. Large tumor the size of a child's head occupying almost the entire rt. abdominal cavity. Urine few red blood cells and epithelial sediment.	No	Calculus extracutaneous or neoplasm not structuring rt. ureter. Hydronephrosis rt.	Cystoscopy protruding mass obstructing rt. ureteral orifice. Nephro-ureterectomy. Patient died 8 hrs after operation with symptoms of embolus.	Autopsy: tumor of rt. ureter. Hydronephrosis and hydronephrosis. Metastases in retroperitoneal nodes, liver and lungs. Microscopic diagnosis: medullary carcinoma rt. ureteral orifice. Scirrhous carcinoma of middle of rt. ureter.
14 (26)	M	47	Recurrent attacks of renal colic over long period of years with history suggestive of passage of stone on two occasions. One month before admission on basis of cramp-like pain in center of abdomen accompanied by nausea. Physical examination: marked tenderness over left kidney and iliac fossa. No masses felt. Urine negative.	Yes	Calculus in left ureter.	Cystoscopy poor visualization due to hemorrhage.	Surgical specimen: tumor and stone lower end of l. ureter. Pyo-ureter pyonephrosis. Microscopic diagnosis: adenocarcinoma of l. ureter.
15 (1)	M	62	Cutting pain in sacral region commencing suddenly 2 weeks before admission and recurring at intervals. Urine voided clear to cloudy. No dysuria, no urgency. Physical examination: tenderness in l. kidney region. Dark brown pigmented spots on lips and buccal mucosa. All other systems negative. Urine: cloudy many white cells and epithelial cells, no red blood cells.	No	Tuberculosis of l. adrenal gland. Adrenocortical insufficiency.	No treatment reported. Patient died 2 mo after admission.	Autopsy: tumor lower left ureter. Hydronephrosis and hydronephrosis. Metastases in retroperitoneal glands. Microscopic diagnosis: papillary and squamous cell carcinoma of l. ureter.
16 (50)	F	36	Hematuria present in lumbosacral region during toilet to bladder. Physical examination: mass in right lower groin.	No	Tumor of right kidney.	Nephrectomy removing large volume of chocolate colored fluid. Patient died.	Autopsy: tumor middle third of rt. ureter. Hydronephrosis rt. Metastases in retroperitoneal glands. Microscopic diagnosis: squamous cell epithelioma of rt. ureter.
17 (17)	F	8	Pain in sacrum and right buttock radiating to right leg 3 mo duration. Frequency and blood tinged urine. No complaint of physical examination negative. Urine: blood tinged, many pus cells, no red cells. No incontinent epithelial cells.	No	Neoplasm of the urinary tract.	No operation. No treatment reported. Patient died 24 days after admission.	Autopsy: tumor of rt. ureter size of hazelnut and 1 cm above ureteral opening. Hydronephrosis and hydronephrosis rt. Metastases in regional lymph nodes. Microscopic diagnosis: papillary carcinoma of rt. ureter.



TABLE I—RÉSUMÉ OF THE FORTY NINE CASES COLLECTED FROM THE LITERATURE—Continued

Case and reference number	Sex	Age	Symptoms and signs	Associa- tion with calculus	Clinical diagnosis	Treatment and course	Pathology
18 (32)	M	65	Recurrent attacks of pain in l lumbar region for many years. Four mo before admission suffered from pain in l flank and bloody urine. Onset of pain acute. Frequency and dysuria also complained of. Physical examination large tumor in l flank without line blood tinged.	Yes	Malignant tumor of l kidney pel- vis. Hydrone- phrosis.	No operation. Patient died 4 days after admission.	A t py t more lower on third of l ureter and th size of a lemon. Inva- sion of adjacent tes & Me- ta-stases in l kidney and retroperitoneal gland. Hydronephrosis & marked hydronephrosis. Macroscopic diagnosis papillary carcinoma of l ureter.
19 (19)	F	60	Tearing acute pain l hypochondrium radiating to l breast. Arm l thigh of 10 yr duration occurring every 3-4 mo. Jaundice also often appeared. Hematuria and dysuria—duration not mentioned. Patient felt tumor in l half of abdomen for 10 yr.	No	Hydronephrosis kidney tumor	Nephrectomy. Died after operation.	Autopsy tumor of l ure- ter. Metastases in liver & Sple. ome-gally (thought to be early Bant disease). Macroscopic diagnosis papillary carcinoma of l ureter.
20 (6)	M	55	Pain in hypogastrium perineum and scrotum—2 yr duration. Nocturnal anuria onset of pain. Hematuria—3 weeks duration. Physical examination negative except for double aneurysm.	No	Neoplasm of l ureter	Cystoscopy blood from l ureter. Obstruction to catheter 15 cm up l ureter. Function tests showed markedly diminished flow of l kidney. Nephro-ureterectomy. No follow-up reported.	Soeical specimen 1 mo size of olive in upper part of l ureter. Seco d nod- le 3 cm lower. Hydronephrosis. Macroscopic diagnosis papillary carcinoma of l ureter.
21 (1)	M	55	Hematuria 10 mo previously. No anal stimulus attacks in interum. 1 coon once of urine 7 mo before admission. Severe pain in l sacro-lumbar region described as sciatica. This had its onset 5 mo previously. 31-lb weight loss firm round non-tender tumor to t of umbilicus and fixed to pos- terior abdominal wall. Rt testicle 5-4 times the size of l. Tenderness over rt. sacro-lumbar region.	No	Sarcoma of rt. ileum	Cystoscopy obstruction in l ure- ter 6 cm from bladder. Biopsy of tumor tissue. Patient then given glandular therapy. Died 30 days after operation and 70 days after admission.	Autopsy tumor ablate l ing center l half of rt. ureter. Extensive necrosis and dissec muscle posterior peritoneum & d lumbar plexus. Macroscopic diagnosis sarcoma of rt. ureter.
22 (7)	F	51	Hematuria 3 mo before entrance in clinic. Recurred 10 to bone weight loss. Physical examination neg. to c. Urine soe l red and white cells.	No	Tumor of l kidney pel- vis or l ureter	Cystoscopy catheter met a resist- ance 5 cm pl. reter. No urine and only a little blood from l ureter. No to q of dye from l ureter during l action test. Nephro-ureterectomy. Patient well 1 year after operation.	Soeical specimen 1 mo size of midpotato. All l ure- ter the size of cherry. Extensive necrosis and dissec muscle posterior peritoneum & d lumbar plexus. Macroscopic diagnosis papillary carcinoma of l ureter.
23 (12)	F	4	Pain in loins of 5 weeks duration. Appeared suddenly at menstrual period. Pain also in hips hypogastrium and rt thigh. Physical examination did not answer questions. Refused all food. Apathetic. Temperatura subnormal.	No	Sciatica, Dementia parva	No treatment reported. In hospital 2 days & second admission and then died.	Autopsy tumor lower end of rt. ureter. Metastases in regional and mesenteric nodes and psoas in scle. Hydronephrosis & l. Macroscopic diagnosis carcinoma of l ureter.
24 (12)	M	3	Hematuria 4 yr previously and again shortly before admission. No other signs or symptoms reported.	No	Papilloma of bladder	Partial resection of l site. l tumor. Secondary hemorrhage 22 days post op. tve. Smooth recovery.	Surgical specimen papil- loma tons tumor of l ureter. Hydronephrosis & l. Macroscopic diagnosis carcinoma of l ureter.
25 (10)	F	65	Mild hematuria 2 mo duration accompanied by frequency but no pain. Physical examination no masses on abdominal palpation. Second admission. Recurrence of hematuria. Mass palpated in rt. upper quadrant, firm freely movable.	No	Malignancy of rt. ureter suspected	Cystoscopy & ureteral catheteriza- tion and drainage of rt. hydronephrosis. Catheter met obstruction 15 cm up rt. ureter. No blood ing followed. Patient discharged but returned 2 yr later with recurrent hematuria and mass in rt. distal rectum. Cystoscopy 2 yr later. Papillary tumor projecting from rt. ureter. Nephro-ureterectomy. Patient died in uremia 4 mo after operation.	Surgical specimen tumor of rt. lower ureter. Hydronephrosis & l. Macroscopic diagnosis papillary carcinoma of rt. ureter with metastases to retroperitoneal lymph nodes.

TABLE I—Continued

Case and reference number	Sex	Age	Symptoms and signs	Association with calculus	Clinical diagnosis	Treatment and course	Pathology
26 (17)	M	55	Several attacks of hematuria over a period of 4 yr. Loss of weight. Urine contained a molar to amount of blood.	No		Cystoscopy: papillary tumor covering the ureteral orifice. Suprapubic cystotomy. Resection of 50 cm of ureter. Lower end of ureter implanted in bladder wall. Patient well at end of 8 month.	Surgical specimen: tumor of ureter, size of pigeon's egg. Microscopic diagnosis: papilloma with inefficient malignant changes.
27 (46)	F	46	Pain in rt. side as long as she can remember. Accompanied by frequency. Attacks of pain more frequent the past year and associated with fever, vomiting and hematuria. Rt. side kidney operation at 15 (indication not given). Physical examination: rt. kidney the size of a child's head. Tenderness over rt. kidney. Urine cloudy, many pus cells.	No	Pyonephrosis	Cystoscopy: rt. ureteral orifice closed. Urine cloudy and came slowly from rt. ureter. No obstruction in either ureter to either. Nephrectomy. Second stage: a ureterectomy 5 mo later. Patient well after 4 weeks. No follow-up.	Surgical specimen: tumor in midportion of rt. ureter. Pyo-ureter pyonephrosis. Microscopic diagnosis: papillary carcinoma of rt. ureter.
28 (40)	F	55	Diffuse abdominal pains and pains in l. lower quadrant for 5 wk. Vomiting about same time followed by headache. Conipated for past 6 mo. Physical examination: pain and tenderness in l. lumbar region. Marked anemia. Urine: hyaline and granular cast.	No	Intestinal obstruction. Tuberculous peritonitis.	Operative procedure not mentioned. Patient died 22 days after admission.	Autopsy: tumor upper end of l. ureter. Extension into kidney. Invasion of psoas muscle and vertebral bodies. Metastases in liver, l. kidney and vertebrae. Pyonephrosis. Microscopic diagnosis: transitional cell carcinoma of l. ureter.
29 (3)	M	73	No history given except that patient died of cardiac and renal insufficiency.	No			Autopsy: rt. kidney beginning malignant sclerosis. L. kidney hydro-nephrotic and ureter halfway down small knobby excrescences reminding one of tuberculous. Proximal end of l. ureter widened and filled with cheesy material. Microscopic diagnosis: papillary carcinoma of l. ureter.
30 (33)	F	55	Pain in rt. kidney region of 5 yr duration associated with fever, rigors, pyrexia, chills, dysuria and frequency for last 3 mo. Also bloody cloudy urine. Patient noticed a mass in rt. side of abdomen during latter part of her illness. Physical examination: small, weak emaciated woman. General ectopic position. A well outlined ballotable tumor the size of a fist in the region of the right kidney. A few smaller masses also palpable below and medial to first. Urine cloudy contained pus and red cells.	No	Tumor of right kidney	Cystoscopy: tumor in region of rt. ureter and of papillary structures. Nephro-ureterectomy. Excision of involved bladder mucosa about rt. ureteral opening. No follow-up reported.	Surgical specimen: tumor in rt. ureter 1 cm above vesical opening and extending 1.5 cm upwards with obstruction of lumen. Mass had a papillary structure. Also hydro-ureter and hydronephrosis. Microscopic diagnosis: papillary carcinoma of the rt. ureter.
31 (7)	M	48	Hematuria of 3 yr duration. Pain in head of penis at end of micturition. X-ray showed a suspicious shadow in the region of the l. ureter.	Yes	L. ureteral neoplasm or l. renal neoplasm without obstruction at that level.	Cystoscopy: bloody urine from l. ureter. Obstruction of same mass by neoplasm and stone. Nephro-ureterectomy and resection of an area of bladder wall were carried out 3 days after first operation. Patient discharged a week later in good condition.	Surgical specimen: papillary tumor 8 cm in diameter involving the lower l. ureter. Pyonephrosis. Microscopic diagnosis: papillary epithelioma of l. ureter.
32 (44)	M	65	Pain in l. kidney region of 6 mo duration. Hematuria for 8 days preceded admission to hospital.			Cystoscopy: obstruction about l. ureteral orifice. Obstruction 8 cm above the orifice. Nephrectomy then secondary operation. Ureterectomy attempted but procedure abandoned due to pressure of a large mass over iliac vessels. Patient died 9 days after operation.	Hydro-ureter. Tumor mass over the iliac vessel.

TABLE I—RESUMÉ OF THE FORTY-NINE CASES COLLECTED FROM THE LITERATURE—Continued

Case and reference number	Sex	Age	Symptoms and signs	Association with calculus	Clinical diagnosis	Treatment and course	Pathology
33 (15)	F	64	Pain in rt. side for 2½ yr of great severity the last 2 mo. Hematuria 2 mo before admission. Physical examination mass in rt. side of abdomen the size of two fists			Cystoscopy catheter in rt. ureter met an obstruction 5 cm above the ureteral orifice. Nephrectomy and later a ureterectomy were performed. Patient was still well 3 yr after the operation	Surgical specimen tumor of rt. ureter hydronephrosis rt. Microscopic diagnosis solid carcinoma of the rt. ureter
34 (16)	M	35	Stabbing pain in rt. flank radiating down course of ureter, of 3 wk duration. Accompanied by vomiting, chills and temperature of 102 degrees. After 5 days the pain subsided. Patient thought he had passed a stone. Hematuria associated with lattice calc. A d. H. constant rt. upper abdominal pain persisted until admission. X-ray calc. in rt. kidney	Yes	Renal calculus	Cystoscopy catheterization of both ureters accomplished without difficulty. Nephrotomy and removal of stones carried out. A mass was felt at the ureteropelvic junction which on section proved to be carcinoma and operation Nephro-ureterectomy	Surgical specimen tumor of rt. ureter hydronephrosis rt. Microscopic diagnosis squamous cell carcinoma
35 (17)	M	40	Pain in the rt. hip radiating to the inguinal region of 4 mo duration. Physical examination slight resistance in hypogastrium—a cord like structure was made out along the course of the rt. ureter (on second admission)	No	Malignancy of ureter	Cystoscopy the ureteral catheter passed up only to the level of the second sacral segment on the rt. side. Patient died before operation	Autopsy carcinoma of rt. ureter. Metastases to liver, lungs, periaortic lymph nodes. Hydronephrosis rt. Microscopic diagnosis papillary epithelioma of ureter
36 (18)	M	74	Hematuria of 3 wk duration. Urine never free of blood since onset. Weight loss of 10 lbs. Physical examination negative	No	Tumor of kidney Hydronephrosis	Cystoscopy showed distention of ureter. No obstruction. Continued to pass blood after the operation	Surgical specimen hydronephrosis. Tumor of ureter. Microscopic diagnosis papillary carcinoma of ureter
37 (19)	F	42	Hematuria and blood clots in urine about every 3 wk for past year. Occasionally associated with frequency and urgency. Severe pain in bladder region for first time 3 days before admission accompanied by urgency, frequency and bloody urine. Physical examination perineal pale and thin. Rt. kidney enlarged moderately tenderness on palpation tenderness down course of ureter. Urine 1 w red cells. X-ray negative	No	Ureteral obstruction probably tumor of kidney Hydronephrosis	Cystoscopy bladder and both ureters orifices normal. Catheter stopped 7 cm up rt. ureter. Bleeding from same side. Rt. kidney returned to normal. Utererectomy in distention of ureter due to obstruction. Utererectomy a successful recovery. Patient still well 3 yr after the operation	Surgical specimen hydronephrosis and hydronephrosis rt. Tumor of ureter. Microscopic diagnosis carcinoma of ureter
38 (20)	F	69	Pain in the lumbar region frequency and hematuria were first noticed 5 mo before admission. These symptoms recurred with increased severity 2 mo later. The pain did not radiate but was constant and was aggravated by motion. A considerable loss of weight was observed. The patient noticed a mass in the rt. side 6 wk before admission. Physical examination slightly enlarged. Rt. kidney 10 cm enlarged. Smaller mass felt in the region of the rt. lower ureter. Laboratory findings: Blood—Hb 40.4 gms 100 c cm. Urea 7.8 mgms 100 c cm. Creatinine 1.3 mgms 100 c cm. Phenolsulphonphthalein test—5 percent from rt. kidney in 15 min. No rt. shadow from left kidney. X-ray—rt. kidney shadow not plainly visible. A vague shadow was seen in the lower ureteral region. The 12th and 13th dorsal vertebrae showed increased density and blurring of the normal markings	No	Malignancy of the upper urinary tract with associated hydronephrosis	Cystoscopy in the ureter an obstruction was encountered 4 cm from the bladder. No ureteral mass felt but blood trickled down also under the catheter. Utererectomy. The patient died 8 months after the operation	Surgical specimen tumor of rt. lower ureter. Hydronephrosis rt. Microscopic diagnosis carcinoma of the ureter

TABLE I—Continued

Case and reference number	Sex	Age	Symptoms and signs	Association with calculus	Clinical diagnosis	Treatment and course	Pathology
30 (37)	M	37	Pain in rt. para-umbilical region radiating along course of rt. ureter of a moderate degree. Also dysuria and pain in rt. testis. Total hematuria not influenced by movement. Loss of 2 kilos of weight in 2 mo. Previous history: prostaticitis 10 yr. before. Physical examination: tenderness and spasm in rt. para-umbilical region. No mass felt. Rt. varicocele. Urine: cloudy in 3 glasses. No hematuria at this examination. X-ray showed slightly enlarged rt. kidney. No stones.	No	Probable neoplasm of upper 1/2 of rt. ureter	Cystoscopy: injection of mucosa about of ureteral orifice. Catheter stopped by the way up rt. ureter followed by bleed. g. Pyelotomy pelvis normal. Rejection of 4 cm. of ureter in region of tumor. Kidney not removed. Oliguria for 4 dy. Patient well 20 dy. after operation. No hematuria.	Surgical specimen: tumor 2 cm. long in upper part of rt. ureter. Mass hard, size of a little nut and adherent to surrounding tissue. Microscopic diagnosis: cylindrical cell epithelioma.
40 (41)	F	54	Hematuria 6 mo. before admission lasting for 2 days and then disappearing. Recurrence of hematuria with addition of pain in rt. side 3 mo. later. A mass gradually developed which could be felt anteroposteriorly below the costal margin.	No		Cystoscopy: catheter met an obstruction 4 cm. above of bcr. Nephrectomy and partial ureterectomy. Uneventful recovery.	Surgical specimen: a papillomatous tumor of the rt. ureter. Microscopic diagnosis: papillary carcinoma of the rt. ureter.
42 (52)	M	70					Autopsy: walnut sized tumor of the rt. ureter at the level of the linea arcuata. Extensive perinephritic abscess behind l. kidney.
4 (15)	F	66	Hematuria and trouble in bladder of 8 mo. duration. Passed pure blood shortly before admission. Physical examination: patient did not look sick. Flexa, symmetric below at ep. Edema in region of both malleoli. Otherwise negative examination. Urine: many red cells.	No	Stenosing carcinoma of l. ureter with hydronephrosis.	Cystoscopy: cherry-sized tumor in rt. ureter at orifice. Tumor cauterized. Nephrectomy and partial ureterectomy 51 dy. after admission. Ureterectomy and resection of portion of bladder wall 47 dy. after first operation. Cystoscopy 16 dy. later showed good bladder wall and no evidence of tumor.	Surgical specimen: tumor filling two-thirds of rt. ureter and projecting 1 cm. orifice. Hydronephrosis rt. Microscopic diagnosis: papillary carcinoma of rt. ureter.
43 (43)	F	75	Pain on rt. side 4 d. hematuria of 8 mo. duration. Pain occasionally radiated to rt. groin. Intermittent frequency. Mictus and some right weight loss also described. Physical examination: feeble old woman. Abdomen: no renal colicament. Tenderness on deep palpation in rt. hypochondriac and rt. lumbar regions. Liver not enlarged. No ascites. Urine: faint trace albumin. No red cells.	No	Tumor of rt. ureter probably primary in origin. Pelvis though possibly primarily situated in ureter.	Cystoscopy: bullous edema and congestion around rt. ureteral orifice. Catheter arrested 15 cm. up rt. ureter and small amount of bloody secretion obtained. L. ureter normal. Many red cells in urine from rt. side. Ureteropyelotomy obstruction l. rt. ureter. Nephrectomy and partial ureterectomy. Post op. felt well at end of 3 wks.	Surgical specimen: sessile papillary tumor covering three-quarters of wall of rt. ureter and 3 cm. in length. Slight dilatation of ureter above tumor but upper 6 cm. of ureter was normal. Rt. kidney normal. Microscopic diagnosis: primary papillary epithelial tumor of the rt. ureter with cyst formation.
44 (45)	F	40	Hematuria for 1 mo. before admission. Associated with pain in left side and dysuria. Physical examination: tenderness in left flank otherwise negative. X-ray: stones in l. kidney region. Enlarged l. kidney.	Yes	None reported.	Cystoscopy: hyperemia about l. ureteral orifice. Catheter stopped about 2 cm. up ureter. No dye return on left. Nephrectomy and ureterectomy. No follow-up of case reported.	Surgical specimen: tumor of l. ureter 4.5 cm. long at level of linea mammillaris. Dilated ureter posterior to and normal ureter distal to mass. Hydronephrosis l. Extension of tumor into retroperitoneal fat. Two enlarged lymph nodes. Microscopic diagnosis: medullary carcinoma of the l. ureter.
45 (44)	F	71	Scatica for 1 yr. Pain in rt. and l. hypogastric regions. Anemia for 3 dy. urethral ed. by her doctor so came to hospital. Physical examination: emaciated old woman. B.P. 44. Right second aortic sound, enlarged tender rt. kidney l. also enlarged, though less tender.	No	None reported.	Cystoscopy: catheter met an obstruction 4 cm. up left ureter. Catheter passed halfway up rt. ureter with return of small amount of concentrated urine. No dye set in. No operation. Diuretics did not relieve anuria. On third day developed flail in both chests. T.p. repeatedly. Died on 4th day in hospital.	Autopsy: tumor 5 cm. in diameter in mid-burial of l. ureter. Hydronephrosis l. rhonchi ephritis pyelonephritis rt. hydronephrosis rt. Microscopic diagnosis: carcinoma of l. ureter.

TABLE I—RÉSUMÉ OF THE FORTY NINE CASES COLLECTED FROM THE LITERATURE—Continued

Case and reference number	Sex	Age	Symptoms and signs	Association with calculus	Clinical diagnosis	Treatment and course	Pathology
45 (1)	M	5	Pain in loins, especially in rt. and hematuria for 3 yr. and 3 mo. Rt. kidney removed 15 mo. previously. Bleeding stopped for a month. However hematuria returned together with pain in rt. iliac and perit. region. Physical examination tenderness in region of rt. ureter and rt. side of bladder. A cord like nodular enlargement was palpated along course of rt. ureter.	No	Tumor of rt. ureter. Undecided as to whether it was malignant or benign until operation.	Cystoscopy 45 mo. before showed bleeding from rt. ureter. Diagnosis of kidney tumor was made and nephrectomy performed. Cystoscopy (on last admission) papillary growth emerging from rt. ureter. Could not with safety be called carcinoma. Ureterectomy then performed. Patient died at home several months later.	Surgical specimen tumor of lower part of rt. ureter. Microscopic diagnosis: med. lary carcinoma of rt. ureter.
46 (22)	M	34	Pain in lumbar region first noted 3 yr. before admission. Had recurrence of pain 1 yr. later and last time was negative 2 mo. before admission. He again began to have lower back pain and began to lose weight and strength. He passed blood clots 2 mo. previous to his appearance at the hospital.	No	Papillary epithelioma of rt. ureter.	Cystoscopy 1st admission was negative. Cystoscopy 2d and 3d admissions showed that small amount of material removed from rt. ureter. Clinical course proved to be papillary epithelioma. Prostatectomy 3 mo. later following continuance of pain and hematuria. A nephroureterectomy was performed. Recurrence of tumor in bladder. Continuance of pain in rt. hip region.	Surgical specimen small papillomatous tumor low down in rt. ureter. Microscopic diagnosis: papillary epithelioma of rt. ureter.
47 (30)	F	6	Painless hematuria occurring at intervals and of 6 mo. duration. Hematuria continuous for 6 wk. before admission. Patient was edematous and treated for such before onset of last illness. A very opaque solution in ureter gave evidence of obstruction on left side.	No	Tumor of ureter.	Cystoscopy bleeding from ureter. Turn of cystoscopy Catheter stopped 15 cm. in ureter. Nephrectomy and ureterectomy following operation. Patient went into a state of coma and died on the 2nd day.	Surgical specimen effluvia of ureter measured 4 by 3 by 1 cm. This was located at point of crossing of ureter and iliac vessels. Extension of tumor into adjacent tissue was apparent. Hydro-ureter, hydronephrosis, microscopic diagnosis: solid richly cellular carcinoma.
48 (8)	M	64	Hematuria 1 yr. before admission. Irritability of bladder only other symptom.	No	Papillary epithelioma of lower 1/3 of rt. ureter.	Nephroureterectomy. Unsuccessful postoperative course.	Surgical specimen tumor of rt. ureter. Hydro-ureter, hydronephrosis, microscopic diagnosis: papillary epithelioma of rt. ureter.

admission. The clinical diagnosis was (1) dermoid cyst of the left ovary (2) nephrolithiasis (left) (3) pyonephrosis (left) (4) cystitis.

**Autopsy findings.** Only the essential findings are presented. When the peritoneal cavity was opened a small amount of a thin blood tinged fluid welled up into the wound. The hollow viscera and omentum were bound to the anterior abdominal wall beneath the region of the surgical incision by dense fibrous adhesions. The serosal surface of all the viscera was smooth and glistening. Examination of the pelvis revealed a large round tumor mass that measured 10 centimeters at its broadest point and that filled the pouch of Douglas. This extended slightly above the pelvic brim and adherent to its upper surface was a loop of ileum. A pale pinkish blue capsule covered the mass. It occupied the site of the left ovary, had a doughy consistency and was firmly bound to adjacent structures by fibrous adhesions. This mass proved to be a cyst partially filled with a thick greenish yellow purulent material interspersed with fine strands of white hair. Both fallopian tubes were firmly fixed by fibrous adhe-

sions. The right ovary together with the uterus, cervix and vagina, were normal. The left ureter was slightly dilated, measuring 0.5 centimeter in diameter. Beginning at the outlet of the left kidney pelvis and extending 5.5 centimeters down the ureter were seen numerous small, irregular, elevated, opaque greyish patches of tumor tissue. These formed discrete islands with intervening portions of mucosa (Fig. 1). This growth extended almost through to the fibrous coat. In the mucosa of the mid third of the ureter were several small translucent elevated cysts (Fig. 1). The kidney was enlarged measuring 17 by 13 by 10 centimeters. It presented a bosselated surface. The renal pelvis was little else than a large multiloculated cavity filled with thick purulent fluid. Adjacent to this the kidney parenchyma was found compressed against the capsule. Two large yellowish brown stones with finger like projections formed a cast of the calyces of the upper and lower poles respectively (Figs. 1 and 1a).

The right ureter was markedly dilated measuring 2 centimeters in diameter. In its midportion were numerous small cysts similar to those seen in the

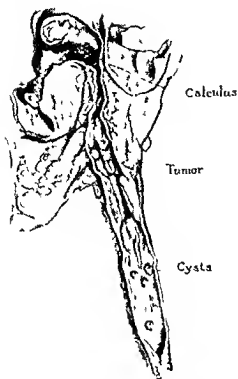


Fig. 1 Drawing of field outlined above showing primary tumor in upper part of ureter

left ureter. One centimeter from the ureterovesical opening a long pointed stone was found completely occluding the lumen. The right kidney measured 16 by 10 by 9 centimeters. Its pelvis and calyces were extremely dilated and the pyramids flattened. No calculi were present in this organ.

The bladder was small and thick walled. Its mucosa particularly in the trigonal region was intensely injected, but not covered by exudate. Injection of the urethral mucosa was also apparent.

The tumor invaded the left kidney and adjacent nerves. Metastatic tumor nodules were present in the regional perigastric and bronchial lymph nodes, also in the adrenal, pancreas, liver, lungs and pleura.

Histological examination of the material from the primary site showed the ureteral mucosa to be completely replaced by tumor. The tumor cells were squamous in type with basophilic cytoplasm and large hyperchromatic vesicular nuclei. Prickle cells were found in many areas. Mitotic figures were not abundant. The tumor cells were often arranged in rounded islands or formed long finger like processes that dipped down into the subjacent musculature. The stroma was moderate in amount and consisted of a loosely arranged collagen tissue with few vessels and small agglomerations of lymphocytes and eosinophiles (Figs. 2 and 3). The metastatic tumor growths

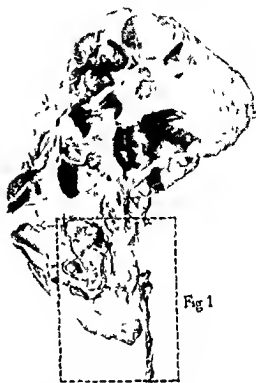


Fig. 2 Pyonephrotic left kidney with calculi in upper and lower calyces

had a cellular morphology similar to the parent tumor (Fig. 4).

Among the interesting findings in this case were the small ureteral cysts previously mentioned. Microscopic study of these structures showed them to be lined with a single layer of flattened or cuboidal epithelium and filled with a pink staining granular or homogeneous material. A thin hyaline lining was often adherent to the inner wall of the cyst (Fig. 5). Islands of epithelial cells were often found beneath these structures. Morse recently gave a comprehensive though terse discussion of this condition—*ureteritis cystica*.

The ovarian cyst was lined with a layer of squamous epithelium. Desquamation of the corneal layer was seen in many places. A broad, dense band of fairly vascular fibrous tissue formed the layer adjacent to the epithelium. A few small collections of lymphocytes were strewn through the connective tissue coat. No changes of a malignant character were found anywhere in this cyst.

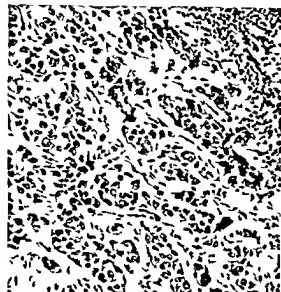


Fig 2 Squamous cell carcinoma at primary site in left ureter  $\times 160$

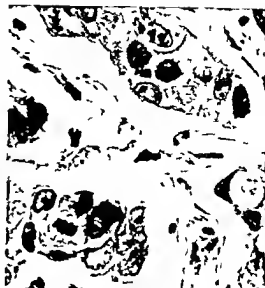


Fig 3 High power of Figure showing detailed cellular morphology  $\times 400$

The sequence of lesions in this case was interpreted as follows. As a result of repeated pregnancies or the presence of the large dermoid cyst, there occurred a bilateral hydro-nephrosis, then infection and calculus formation. In the left ureter, a squamous cell carcinoma developed that metastasized to the situations already mentioned. In addition to the carcinoma and dermoid cyst a diffuse adenomyomatosis of the left fallopian tube was found following the routine section of this appendage. The patient, therefore, presented three distinct types of neoplasms.

#### INCIDENCE

Carcinoma of the ureter occurs in both sexes with about the same frequency. In this group there were 25 males and 24 females affected. The age limits varied from 35 years to 89 years with the frequency increasing in the later decades. Over 60 per cent of this series occurred in individuals above 50 years of age.

#### SYMPTOMATOLOGY

Pain and hæmaturia are the symptoms that stand out with startling constancy throughout all these histories. One or the other was complained of in every instance and both were

present in over 50 per cent of the cases. The pain was usually referred to some region along the course of the urinary tract. Adjectives descriptive of its character were varied—sharp, colic-like, cutting, stabbing, tearing—all found their place in the patients' stories. The pain often radiated along the course of the ureter, simulating the clinical picture of renal calculus, so that this diagnosis was made in some instances. Other symptoms, such as urgency, frequency, dysuria, nocturia, incontinence, anorexia, vomiting, chills, loss of weight and the sensation of a mass were repeated in only a few cases.

#### DIAGNOSIS

The recognition of this lesion is seldom accomplished. In only 14 of these cases was a diagnosis of tumor of the ureter made or even the condition suspected before operation or before necropsy. Tumor of the kidney or renal stone were the two conditions most frequently confused with this disease. A history of hæmaturia and pain, the finding of a ureteral obstruction on catheterization and X-ray films negative for stones are strongly suggestive of a growth in the ureter. It is probably impossible to give a positive opinion



Fig 4 Cell type of primary tumor reproduced in metastatic liver nodule  $\times 160$



Fig 5 Cysts in ureteral mucosa distal to tumor (ureteritis cystica)  $\times 160$

of the nature of the growth at this stage. Increasing weakness and weight loss are ominous signs that help to establish the malignant character of the process. An associated hydro-nephrosis may aid in centering the attention on a lesion distal to the kidney.

#### PATHOLOGY

The most common type of ureteral carcinoma is the so called papillary carcinoma. On gross examination, as the name implies, it presents a surface with papillary or villous projections. Histologically these tumor cells closely resemble those of transitional epithelium and have the irregularity of outline, mitotic figures, and invasive qualities which distinguish any malignant growth.

Other forms of ureteral carcinoma are less frequent and may be grouped for the sake of convenience as non papillary carcinomata. These include the squamous cell type, the adenocarcinoma and the medullary or solid carcinoma. As with other neoplasms, the nomenclature is dependent on the individual describing the case. Our case proved to be a squamous cell carcinoma. Only five other such tumors are found in the literature.

Metaplasia of the epithelium of the kidney

pelvis and ureter from the transitional to the squamous form, is not an uncommon occurrence, particularly in the presence of stones. The natural inference is that these squamous cell tumors follow such metaplasia.

The irritative action of stones as a causative factor in renal tract tumors is a theory advanced by many. Albarran, in a review of 53 cases of benign and malignant epithelial tumors of the renal pelvis and ureter, found stones present in eight instances and believed that they played a role in the development of these tumors. We are unable to reach a similar conclusion. In the case reported here a calculus was found immediately adjacent to the primary growth. On the other hand, in only 6 of the collected cases were stones present anywhere along the urinary tract. One of the sequelae of prolonged ureteral obstruction is hydronephrosis. The palpation of a large hydronephrotic sac has frequently proved misleading in that a diagnosis of such a condition has been made, ignoring the possibilities of a lesion lower down in the urinary tract.

#### TREATMENT AND PROGNOSIS

The prognosis in these cases is exceedingly grave. From the previous table, it will be



noted that 30 patients died while under treatment or within a few months after leaving the hospital. Of the remaining 19, the longest followed patient was that of Crance and Knickerbocker (9), their patient being well after 2½ years. Two authors (Chian, Suter) reported symptom free periods of one year in each of their respective cases. All the other reports gave very short periods of well being or concluded the case with some non committal expression as 'uneventful recovery.' As to treatment the procedure of choice is uretero-nephrectomy, preferably via the lumbar route.

## SUMMARY

Primary carcinoma of the ureter is a rare lesion. Previous to the case reported here only 49 cases have been recorded in the literature. The most common type of carcinoma is the so called papillary epithelioma. Less frequent is the squamous cell tumor of which the present case is an example. Ureteral carcinomata metastasize widely, traveling by venous and lymphatic channels. Renal calculi are occasionally associated with this neoplasm. Many authors believe that stones by their irritative action are an important causative factor in the production of epithelial tumors of the genito urinary tract. In the cases here reviewed no frequent association of stones and tumor could be discovered. The two most constant symptoms of this disease are pain and hæmaturia. The condition is rarely diagnosed before operation or necropsy. X-ray and cystoscopic examinations are the most important diagnostic aids. Removal of the affected ureter and kidney is the treatment of choice. The course of the disease following any form of treatment has been discouraging. In only one recorded case was the patient symptom free 2½ years after being first observed.

We wish to express our appreciation to Dr W. C. von Glahn and Dr F. B. St. John for their help in assembling this paper and to Dr J. Jobling and Dr A. O. Whipple for the use of their record.

## BIBLIOGRAPHY

- 1 ADLER L. Monatsh f Urol 1907 x 120
- 2 ALBARRAN J and IMBERT L. Les Tumeurs du Rein Paris 1903
- 3 ASCHNER P W. Surg, Gynec & Obst 1922 xxv 749
- 4 BLATT P. Wien klin Wchnschr 1906 xxxv 1130
- 5 BUTLER F A. Clifton Med Bull 1914 ii 48
- 6 CHEVASSU M and MOCK J. Bull et mém Soc de chir de Par 1912 xxxviii 522
- 7 CHIARI O M. Ztschr f Urol 1914 xvi 62
- 8 CRANCE A M and KNICKERBOCKER H J. J Am M Ass 1924 lxxvii 1030
- 9 Idem J Urol 1927 xlvii 121
- 10 DAVY R. Brit M J 1884 ii 131
- 11 DAY FAIRCHILD and MARTIN. Surg Gynec & Obst 1923 xl 486
- 12 FENSTERER. Wien klin Wchnschr 1915 xvi 18
- 13 GERSTEIN K. Inaugural Dissertation Kiel 1902
- 14 GLAS R. Wien klin Wchnschr 1906 xxxv 1143
- 15 GOTTLIEB J. Ztschr f urol Chir 1906 xx 230
- 16 HERTOGEN L. J Am M Ass 1896 xvi 1115
- 17 HOFMANN K R. Ztschr f Urol 1916 x 369
- 18 HUNT V C. Surg Clin N Am 1927 Dec 1464
- 19 ISRAEL J. Berl klin Wchnschr 1910 xlvii 2381
- 20 JONA G. Centralbl f allg Path u path Anat 1894 v 699
- 21 JUDD E S and STRUTHERS J E. J Urol 1921 vi 119
- 22 JUDD E S PARKER and MORSE. Surg Clin N Am 1926 vi 1143
- 23 KNACK. Deutsche med Wchnschr 1918 xlv 982
- 24 KRETSCHEMER H L. Surg Gynec & Obst 1924 xxxviii 47
- 25 MEERKE L H and MCCARTHY J J. Am M Ass 1923 lxxvii 104
- 26 METCAL W F and SAFFORD H E. Am J M Sc 1902 cxxix 30
- 27 MENICH K. Pester med-chir Presse 1902 xxxvii 947
- 28 MORSE H D. Am J Path 1928 iv 33
- 29 MIRAZ J Z. J Urol 1924 xii 49
- 30 NILSEN A. Kristiania kirurg forf 1915 viii
- 31 PAPP M J. J urol 1924 xvii 35
- 32 PASCHKE R. Wien klin Wchnschr 1910 xxvii 361
- 33 PASCHKE R and PLESCHNER H. Med Klin 1920 xvi 1234
- 34 POLL B. Beitr z klin Chir 1909 xxviii 822
- 35 POSNER H L. Monatschr f Geburtsh u Gynaek 1926 lxxv 86
- 36 RAYER P. Traite des Maladies des Reins. Paris J B Baillière 1841 Tome III Obs VI
- 37 RICHTER J. Ztschr f Urol 1909 ix 416
- 38 RENDLE H. Tr Path Soc Lond 1896 xlviii 128
- 39 SCHMIDT K. Fortsch a d geb d Roentgenstrahlen 1922 xxxvii 825
- 40 SCHMIDT E C. J Cancer Research 1916 i 461
- 41 SPIES P. Centralbl f allg Path u path Anat 1915 xxxv 333
- 42 STEWART R L. Brit J Surg 1926 viii 667
- 43 St Thomas Hospital Reports 1904 xxxii 96
- 44 SUTER F. Ztschr f urol Chir 1922 x 322
- 45 TOUPET and GUYNOT P. Bull Soc anal de Par 1898 xi 6
- 46 VAN CAPELLEN. Beitr z klin Chir 1916 xcix 139
- 47 VOELCKER A F. Tr Path Soc Lond 1893 xlvii 133
- 48 VORPAIL K. Am J Urol 1902 ii 300
- 49 WESING P J and BLIX C. Hygiea 1884 d 4/8
- 50 ZIRONI Ann d mal d org génito-urin 1900 ii 81
- 51 ZOBEL H. Centralbl f allg Path u path Anat 1922 xxxvii 142

# RIGHT PARADUODENAL HERNIA AND ISOLATED HYPERPLASTIC TUBERCULOUS OBSTRUCTION

CONSISTENT AND REPORT OF CASE AFFECTING JEJUNUM AND ILEUM, OPERATION AND RECOVERY<sup>1</sup>

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**B**OTH right paraduodenal hernia and hyperplastic tuberculosis of the jejunum and ileum are exceedingly uncommon. The first never has been diagnosed clinically and the second in such a situation has been described only occasionally. Their association in the same lesion, therefore appears to be unique, and for this reason they will be discussed separately before an attempt is made to correlate them.

## REPORT OF CASE

The patient, a male Sioux Indian, aged 41 years, first came to The Mayo Clinic 5 months prior to operation complaining of somewhat vague stomach trouble. Twelve years previously he had had a gastro-intestinal upset associated with urticaria following a meal of canned corn. From then on he had suffered from mild intermittent attacks of epigastric pain which had come usually during harvest time and had occurred to 5 hours after meals. These attacks had been associated with considerable bloating and belching and occasional attacks of vomiting. He had noticed that rough foods were particularly likely to precipitate them. He stated that during the attacks a balloon like mass seemed to appear in the right upper abdominal quadrant and that after some time it disappeared with considerable intestinal gurgling. He was not constipated, had never been jaundiced and his appetite was good. For 3 months prior to admission to the clinic the attacks had become somewhat more severe and he had lost 15 pounds.

On examination the patient appeared to be in good general condition except for some loss of weight. The only observation of note objectively was that intestinal borborygmi were somewhat prominent and that an occasional distended loop of intestine could be felt. Definite masses or organs could not be palpated and at this time particular interpretation was not placed on the increased intestinal peristalsis. Laboratory tests did not reveal anything unusual in the urine and blood. Fractional analysis of gastric content disclosed complete absence of free hydrochloric acid. Roentgenographic studies of the chest, stomach and colon were entirely negative but cholecystography revealed a poorly functioning gall bladder. Since the evidence

seemed to point toward low grade infection of the gall bladder the patient was treated medically with a smooth high calorie diet designed to combat constipation and with dilute hydrochloric acid.

Four months later the patient returned feeling worse. The abdominal distention and discomfort in the right upper quadrant were more marked and the belching more severe. He stated that about every 5 minutes he suffered from mild attacks of pain coincident with the gurgling reduction in size of the distended abdomen. He also vomited more frequently with relief of the distress. His bowels were inclined to be loose and the two or three daily stools were clay colored. He had not had jaundice or colic.

Careful examination did not disclose anything further than achylia and a poorly functioning gall bladder. A diagnosis of probable cholecystitis was made with the possibility of chronic intestinal obstruction. In view of this fact exploratory laparotomy was advised.

At operation the gall bladder was found to be perfectly normal. It was next observed that the proximal part of the jejunum was enormously dilated and hypertrophied. Further exploration revealed a large right paraduodenal hernia containing at least three quarters of the small intestine (Fig. 1). The orifice of the hernia was oval in shape, about 10 centimeters in length and was situated to the left of the mesentery and over the lumbar part of the spinal column. It was directed diagonally from left to right in about the same axis as the root of the mesentery. The superior mesenteric artery occupied the right anterior free edge of the opening and as it disappeared into the sac was kinked over the edge. The entering coil of jejunum about 60 centimeters from the duodenojejunal juncture was enormously dilated and hypertrophied. The emerging coil of ileum was collapsed. When the hand was inserted the hernia was found to be of huge size to extend about 25 centimeters down and to the left toward the left iliac fossa and to lie entirely behind the posterior parietal peritoneum.

When the contained intestine was withdrawn it was found to be in a most remarkable condition. About 30 centimeters proximal to the point where the ileum left the hernia and about 120 centimeters from the ileocecal valve was a hard fibrous thickened concentric contraction of the wall of the bowel 3 centimeters in length the lumen of which would scarcely admit the tip of the finger. It re-

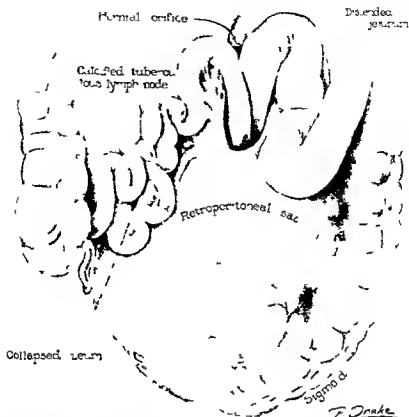


Fig 1 Right paraduodenal hernia showing small intestine herniated into large retroperitoneal sac

sembled somewhat the pylorus. The distal loops of intestine were collapsed. The proximal loops were enormously and irregularly distended, hypertrophied, congested and filled with fluid. Just proximal to the obstruction the ileum was in size equal to that of a capacious stomach. Ninety centimeters proximal to this it had narrowed somewhat but would still have admitted the whole hand. The walls were at least four times the normal thickness of the ileum (Fig 2). After the hernia was reduced the opening was closed with a number of interrupted stitches of catgut. At this point in the operation it was noted that the mesentery of the small intestine contained many calcified tuberculous lymph nodes in the region draining the intestinal tumor. At the time these were thought to represent old healed *tubercles mesenterici*. In view of the fact that the possibility of a malignant condition had to be considered and that the obstruction of the bowel was thought to be due more to the contracted region than to the hernia, the pylorus-like mass was resected from the ileum and an end-to-end anastomosis was performed. At the same time an enterostomy tube was inserted into the most dilated

portion of the ileum in order to prevent any ileus which might result from the extensive handling of the bowel. The fluid in the ileum was markedly blood stained. The condition was one of subacute intestinal obstruction.

The postoperative course of the patient was fairly uneventful. Fluids by mouth were withheld for 4 days. During this time 10 per cent solution of glucose and 1 per cent sodium chloride were administered subcutaneously and intravenously. On the eighth postoperative day the enterostomy tube slipped out coincidentally with the establishment of normal bowel movements. Following this the patient recovered rapidly.

Pathological examination of the resected specimen showed it to consist of 3 centimeters of ileum in the wall of which was a firm nodular annular mass 3 centimeters in length involving its whole circumference and producing almost complete obstruction of the lumen (Fig 2). Through this a lead pencil could scarcely be passed. The wall of the bowel proximal to the lesion was markedly thickened and hypertrophied particularly as regards the muscular layers. It measured 5 millimeters in thick-

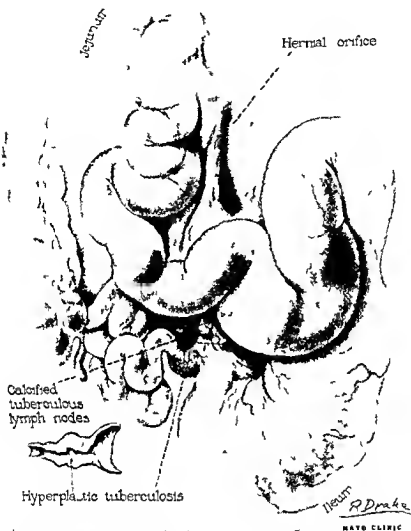


Fig 2 The hernia reduced Tuberculous obstructive lesion and huge dilatation of the proximal ileum and jejunum are shown Insert the tumor in longitudinal section

ness The portion of the wall of the bowel distal to the lesion was of normal appearance and thickness The peritoneum covering the lesion was markedly fibrosed and finely granular, although typical tubercles were not visible On section the involved area was 1 centimeter in thickness from the mucosa to the peritoneum The mucous membrane appeared polypoid and heaped up and to occupy practically the whole lumen but ulceration could not be observed The cut surface was uniformly firm dull white and seemed to consist chiefly of fibrous tissue

Microscopically the mucosa was found to be everywhere intact the polypoid appearance observed grossly was due to tremendous infiltration of

the mucosal villi by small lymphocytes plasma cells, and particularly by eosinophilic leucocytes (Fig 3) The submucosa was markedly increased in thickness both by the cells mentioned and by fibroblasts and epithelioid cells A large number of sections was made to determine the presence of typical tubercles in this region and they were identified only after considerable searching (Fig 4) The muscular layer was enormously hypertrophied and infiltrated with small lymphocytes fibroblasts and epithelioid cells In this region fewer eosinophiles were noted and giant cells were not identified In the subserosa was striking hyperplasia of fibrous tissue and an increase in the amount of tuberculous granulation



Fig 3 Photograph of a portion of the mucosa in the tumor showing the intact epithelium and the dense submucosal cellular infiltration (X 15)



Fig 4 Photomicrograph of a typical tubercle with giant cell in a section taken from the obstructive lesion (X 15)

tissue Concentric aggregations of lymphoid cells surrounded by epithelioid cells and fibroblasts were more numerous here than elsewhere None of these was necrotic Giant cells were more easily found but they were not numerous in any section An epithelioid cell reaction combined with fibrous tissue hyperplasia appeared to be the most prominent feature of this region The impression was gained that this was a very old lesion This impression was strengthened by the discovery at operation of several calcified tuberculous mesenteric lymph nodes in the region draining this particular segment of bowel In view of the absence of mucosal ulceration the diffuse hyperplasia of fibrous tissue infiltration with lymphocytic and epithelioid cells the relative absence of tuberculous giant cells and the non-caseating nature of the lesion the diagnosis was considered to be hyperplastic tuberculous of the ileum

#### PARADUODENAL HERNIA

Nagel in his comprehensive report in 1923 found only 29 cases of the rare right paraduodenal hernia and more than 100 of the more common left variety In these 29 cases 12 of the patients had been operated upon with resultant cure of 2 and death of the remaining 10 Novak and Sussman in 1924

reported an additional case in which cure followed operation, and Bernardberg reported that operation was not successful in a case in which acute obstruction had occurred In 1925, Brown added his case in which operation was successful with a summary of those already reported He found a total of 32 cases, in 15 of which operation had been done with 11 deaths and 4 recoveries, in the other 17 cases the condition was found at necropsy The case forming the basis of this report represents the thirty third with right paraduodenal hernia and the fifth patient to be cured by operation despite the added handicap of most severe and long standing chronic tuberculous intestinal obstruction The diagnosis has not been made before operation or necropsy in any case This case is the third in which paraduodenal hernia has been observed in The Mayo Clinic The first a left sided hernia was reported by Desjardins the second a typical right paraduodenal hernia was reported by Nagel Both were found at necropsy

Moynihan, to whom much of our knowledge of retroperitoneal hernias is due, described 9 varieties of peritoneal fossae in the immediate neighborhood of the duodenojejunal juncture. Of these only 3 cases, or possibly 4, have any practical significance from the standpoint of herniation. These are the superior and inferior paraduodenal fossae, the fossa of Landzert, and that called by Moynihan the mesentericoparietal fossa, and by others the fossa of Waldeyer. Anatomically the first and second are most commonly seen and consist of thin, avascular double folds of peritoneum running transversely from the duodenojejunal juncture to the posterior abdominal wall. The space normally included beneath them scarcely admits the finger tips. When they are not more than 2 to 3 centimeters apart they are usually united laterally, forming a semicircular fold which contains, about 5 millimeters from its free edge the inferior mesenteric vein and a branch of the left colic artery. The space beneath this fold, when present constitutes the fossa of Landzert. When the superior and inferior paraduodenal folds are widely separated, the fossa of Landzert does not exist. Left paraduodenal hernia is generally believed to occur into this fossa and to course upward outward, and to the left behind the posterior parietal peritoneum. The two other characteristics of this type of hernia are that the orifice is turned toward the right and its anterior free edge contains the inferior mesenteric vein. It is the most common of all varieties of retroperitoneal hernia. The case reported by Desjardins was of this kind. Coley (8) recently reported a good example of the condition.

The mesentericoparietal fold is described as lying at the root of the mesojejunum, anterior to the lumbar part of the spinal column and containing the superior mesenteric artery in its anterior free margin. The fossa so formed lies to the right of the body and its orifice opens toward the left. In the opinion of Moynihan, this fossa is always responsible for the development of right paraduodenal hernia. On the other hand, Nagel, from an examination of a large number of fetuses and bodies seen at necropsy, did not find exam-

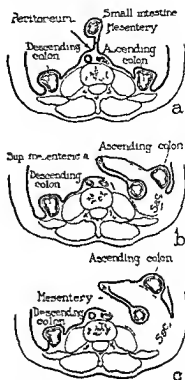


Fig. 5. a The normal disposition of the peritoneum b the relationship of the small intestine and the hernial sac to the peritoneum. c a further stage showing the ascending colon lying anterior to the hernial sac.

ples of this fossa but described in several instances an exceedingly low situation of the inferior paraduodenal fold such that it was practically in the position of Moynihan's mesentericoparietal fossa. Although he did not deny the possibility of right paraduodenal hernia occurring into the fossa of Waldeyer he concluded that it could sometimes take place into the inferior paraduodenal fossa particularly when this was situated near the beginning of the third portion of the duodenum. The drag of the hernial contents would then quickly cause the descent of the orifice by the peeling back of the superior peritoneal margin until it was arrested by the first fixed structure it could encounter namely, the superior mesenteric artery. In this way the superior mesenteric vessels would come to lie in the right anterior border of the orifice. Nagel's explanation seems to be a rational one. In an experience gained from more than 1,200 necropsies, in which an



Fig. 3. Photograph of a portion of the mucosa in the tumor showing the intact epithelium and the dense submucosal cellular infiltration. X



Fig. 4. Photomicrograph of a typical tubercle with a central cell in a section taken from the obstructive lesion. X

the concentric aggregations of lymphoid cells surrounded by epithelioid cells and fibroblasts were more numerous here than elsewhere. None of these was necrotic. Giant cells were more easily found but they were not numerous in any section. An epithelioid cell reaction combined with fibrous tissue hyperplasia appeared to be the most prominent feature of this region. The impression was gained that this was a very old lesion. This impression was strengthened by the discovery at operation of several calcified tuberculous mesenteric lymph nodes in the region draining this particular segment of bowel. In view of the absence of mucosal ulceration the diffuse hyperplasia of fibrous tissue infiltration with lymphocytes and epithelioid cells, the relative absence of tuberculous giant cells and the non-casating nature of the lesion the diagnosis was considered to be hyperplastic tuberculosis of the ileum.

#### PARADUODENAL HERNIA

Nagel in his comprehensive report in 1923 found only 29 cases of the rare right paraduodenal hernia and more than 100 of the more common left variety. In these 29 cases 12 of the patients had been operated upon with resultant cure of 2 and death of the remaining 10. Novak and Susman in 1924

reported an additional case in which cure followed operation and Bernardberg reported that operation was not successful in a case in which acute obstruction had occurred. In 1925 Brown added his case in which operation was successful with a summary of the already reported. He found a total of 33 cases in 14 of which operation had been done with 11 deaths and 4 recoveries in the other 17 cases the condition was found at necropsy. The case forming the basis of this report represents the thirty-third with right paraduodenal hernia and the ninth patient to be cured by operation despite the added handicap of most severe and long-standing chronic tuberculous intestinal obstruction. The diagnosis has not been made before operation or necropsy in any case. This case is the third in which paraduodenal hernia has been observed in The Mayo Clinic. The first a left-sided hernia was reported by DeJardin, the second a typical right paraduodenal hernia was reported by Nagel. Both were found at necropsy.

cholecystitis, chronic duodenal ulcer, or, as Brown suggested, chronic duodenal ileus may lead to long continued and unavailing medical treatment or to operation. When the symptoms become of definite clinical significance they may assume the aspect of recurrent attacks of subacute or chronic strangulation or of acute intestinal obstruction. Vomiting is uncommon and is usually confined to bile stained mucus even when obstruction becomes complete. Brown stated that fecal vomiting cannot occur, owing to the high situation of the obstruction, but this certainly would not hold true in our case in which the obstruction was within 120 centimeters of the ileocecal valve. Visible peristalsis and a palpable, resonant, gurgling, balloon like tumor in the lower right abdominal quadrant, later in involving the whole abdomen, are considered by Moynihan to be the most significant diagnostic signs. That this tumor bears a definite relation to the clinical condition of the patient is well exemplified in our case. During the attacks of dyspepsia, the tumor became tense and tender, and coincident with a series of sharp pains in the right upper quadrant became visibly smaller, with the association of marked borborygmi. Roentgenographic studies have not aided in the diagnosis. In Nagel's case the colon was found to be on the left side, with the small intestines grouped to the right, this appearance was interpreted as representing incomplete rotation of the intestine. In our case, roentgenographic studies of the stomach and colon gave entirely negative results. It is not clear why the dye test should have indicated a poorly functioning gall bladder. When complete strangulation occurs, the picture is more obvious. It is accompanied by severe toxæmia and collapse, owing to the large amount of small intestine involved.

*Treatment.* The treatment of the condition is essentially surgical. The reduction of the hernia is easily attained since adhesions are not often found. In Brown's case it was possible to remove the entire sac by everting it but in the usual type this is not feasible. It is however very necessary to close the orifice to prevent recurrence, an accident which has occurred in at least 2 cases (21-26).

During this procedure the large vessels at the neck of the sac should be carefully avoided. Because of their presence, the neck should be enlarged only with the greatest caution. It is of course, entirely because of the difficulty in diagnosis and the severity of the intestinal obstruction for which operation is most often performed that the mortality is so high.

#### HYPERPLASTIC INTESTINAL TUBERCULOSIS

According to the French classification, tuberculosis of the intestine exists in 4 pathological forms (4, 6). (1) The ulcerating, lenticular type commonly known as tuberculous enteritis, it may exist as a primary lesion in children but in adults is practically always secondary to advanced pulmonary tuberculosis. (2) The cicatricial, or stenosing, type resulting from healing of an annular ulceration of the wall of the bowel. The lesion may be single or multiple and commonly affects the small intestine. Its appearance is that of a ligature tied around the bowel. In the ileum it may produce marked obstruction, but rarely does so in the large intestine, where it forms a shelf like projection into the lumen. The literature contains many reports of this type of ileal involvement (16, 29). Although the pathological effects are the same and the treatment is identical, it should be sharply distinguished from the variety occurring in our case. (3) The enteroperitoneal variety is characterized by ulcerating, cascading lesions of the ileocecal segment, with peritoneal and lymphatic involvement and a marked tendency to softening and suppuration. External fistule and spontaneous entero-entero-anastomosis is common. Very large caseous lymph nodes frequently co exist with the condition. (4) Chronic hyperplastic tuberculosis is a distinctive variety of tuberculosis and was first described by Hartmann and Pillet in 1891. Conrath later reviewed 77 cases and considered them carefully from a surgical standpoint. Lartigau's monograph, however, may be considered the most exhaustive pathological study of the whole subject. Little has been added since its appearance.

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examination as a routine was made for abdominal normal peritoneal folds, we did not find mesentericoparietal folds of noteworthy size but did encounter several inferior duodenal fossæ of large dimensions and one into which the whole hand could be inserted, but which did not contain bowel. Sistrunk recently found a large fossa of Landzert which would admit the whole hand but which did not contain loops of bowel. It would seem that the sac may exist as a potential hernia throughout life. Andrews was opposed to the explanation of both Moynihan and Nagel on the basis that the condition is not a hernia in the true sense of the word but rather a congenital anomaly due to imprisonment of the small intestine beneath the mesentery of the developing colon. He strongly objected to the conception of a *vis a largo* which could produce a hernial sac from one of the normally insignificant paraduodenal fossæ. He pointed out that differential pressure cannot occur in the abdomen, that hundreds of such fossæ, none of which contains herniated bowel, exist in the abdomen, that the herniation is usually total or subtotal, and that the hernias are practically always small. His explanation, although plausible, is not without its objections. It does not explain, for instance, the anterior situation of the sac in the case reported by Brown. Of the many theories advanced, the most rational seems to us to be that which considers such sacs of congenital origin or as variations of the normal process of zygosis. In this way they are somewhat analogous to the congenital inguinal sacs. That they are occasionally found to be of considerable size without contents is undoubted. Once a loop of bowel becomes included within such a potential peritoneal sac the *vis a largo* derived from vigorous peristalsis is by no means lacking and enlargement rapidly occurs. This force would further account for large hernias found either in childhood or in adult life.

Whether right paraduodenal hernia occurs into the inferior paraduodenal fossa or into the fossa of Waldeyer, its characteristics are that the orifice finally lies practically in the median line or slightly on the right side of the spinal column that it is turned to the left

and that it contains the mesenteric artery in the right free border. Furthermore the hernia passes downward and generally to the right behind the parietal peritoneum and the colon. In Brown's case, the sac lay anterior to the peritoneum and the colon although in other respects it was typical of the condition. When the sac is large as it generally is it may contain large amounts of small intestine. The usual disposition of the sac with regard to the parietal peritoneum is illustrated in Figure 5.

**Pathological features.** Intestinal obstruction is the most common pathological feature of the condition. Usually, when clinically obvious, it is acute. Of the 33 cases reported in the literature, obstruction was acute in 13, subacute in 1 case, and chronic in 1. Operation was undertaken in 14 cases for this complication alone. Obstruction is also the outstanding cause for the symptoms from which the patient suffers. It is caused by constriction of the orifice, by adhesions at this site, or by volvulus of the contents at the neck of the sac. An extrahernial cause may be duodenal obstruction from dragging on the superior mesenteric artery. In the case reported here, obstruction, although occurring entirely within the sac, apparently had little to do with the mechanics of the hernia, for the area of hyperplastic tuberculosis was situated not at the neck of the sac, but at least 30 to 35 centimeters proximal to the point of emergence of the ileum. The bowel distal to it was collapsed and that proximal to it enormously dilated and hypertrophied. On this basis, it must be assumed that the tuberculous lesion was at least 12 years old, a point which will be discussed further. Chronic and long standing obstruction may give rise to dilatation and hypertrophy of the intestinal wall of an extreme nature. In this case the ileum and jejunum had reached enormous proportions (Fig. 2).

**Clinical diagnosis.** The fact that right paraduodenal hernia never has been diagnosed before operation or necropsy indicates that the clinical symptoms are at the best vague and indeterminate. In certain cases the condition has been symptomless in other cases vague dyspepsia suggestive of chronic

cholecystitis, chronic duodenal ulcer, or, as Brown suggested, chronic duodenal ileus may lead to long continued and unavailing medical treatment or to operation. When the symptoms become of definite clinical significance they may assume the aspect of recurrent attacks of subacute or chronic strangulation or of acute intestinal obstruction. Vomiting is uncommon and is usually confined to bile stained mucus even when obstruction becomes complete. Brown stated that fecal vomiting cannot occur, owing to the high situation of the obstruction, but this certainly would not hold true in our case in which the obstruction was within 120 centimeters of the ileocecal valve. Visible peristalsis and a palpable, resonant gurgling, balloon like tumor in the lower right abdominal quadrant, later involving the whole abdomen, are considered by Moynihan to be the most significant diagnostic signs. That this tumor bears a definite relation to the clinical condition of the patient is well exemplified in our case. During the attacks of dyspepsia, the tumor became tense and tender, and coincident with a series of sharp pains in the right upper quadrant became visibly smaller, with the association of marked borborygmi. Roentgenographic studies have not aided in the diagnosis. In Nagel's case, the colon was found to be on the left side, with the small intestines grouped to the right, this appearance was interpreted as representing incomplete rotation of the intestine. In our case, roentgenographic studies of the stomach and colon give entirely negative results. It is not clear why the dye test should have indicated a poorly functioning gall bladder. When complete strangulation occurs, the picture is more obvious. It is accompanied by severe toxemia and collapse owing to the large amount of small intestine involved.

**Treatment.** The treatment of the condition is essentially surgical. The reduction of the hernia is easily attained since adhesions are not often found. In Brown's case it was possible to remove the entire sac by everting it but in the usual type this is not feasible. It is, however, very necessary to close the orifice to prevent recurrence, an accident which has occurred in at least 2 cases (21-26).

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affecting various segments of the intestinal canal and characterized by a variable, but considerable hyperplastic, annular thickening of the wall of the bowel, which is bound to the parietes by adhesions so that the tumor is rarely free or movable. In most cases (90 to 95 per cent) it affects the ileocecal region here constituting the well known ileocecal tumor. Occasionally the rectum is involved, less commonly the ileum in conjunction with the cecum, and almost never the ileum alone. It is a disease of long duration the most conspicuous feature is the extensive formation of fibrous and tuberculous granulation tissue in the involved regions. Necrosis and caseation as a rule *do not occur* and ulceration unless of the ordinary enteric type is not seen. The chronicity of the disease and its low grade of inflammation are believed to be due either to an attenuated bacillus or to one of low virulence elaborating small quantities of exotoxin sufficient only to produce proliferation, and not necrosis of fibrous tissue. The formation of tumor is the ultimate result. Clinically this may be mistaken for carcinoma and even at operation the diagnosis is not always clear (19, 27). Lartigau stated that many of the early cases of cecal resection for supposed malignant conditions reported as cured were really examples of this condition. On section the lesion has the uniform whitish appearance of hyperplastic fibrous tissue. The blood supply appears to be relatively well preserved this probably accounts for the absence of caseation necrosis. The mucosa becomes heaped up and assumes a *polypoid or papillomatous appearance* due to the underlying infiltration. This process continues to the complete obliteration of the lumen of the bowel. Involvement of the regional lymph nodes with or without caseation is the rule. In the rectum the condition may be mistaken for syphilis.

Microscopically the process is essentially a mixture of a purely tuberculous and a simple inflammation so that the picture necessarily varies within wide limits. If the mucous membrane is intact as it often is the epithelium is normal but the villi are greatly enlarged and swollen with masses of lymphoid and epithelioid cells and occasional typical tuber-

cles. Fibroblasts are thickly interspersed in the region of cellular infiltration. These polypoid masses often alternate with areas of ulceration of the same cellular appearance except that the superficial epithelium is absent and fibroblasts are more numerous. The submucosa is greatly thickened by fibroblastic hyperplasia and by lymphoid cells. Giant cells are considered to be most common here. In the muscular layer is seen marked hypertrophy of the muscle bundles which are separated and in places destroyed by aggregations of lymphoid and epithelioid cells. In the subserosa many lymphoid collections and fibroblasts are to be seen. Considering the uniformity and intensity of the cellular infiltration, it is surprising that necrosis does not occur. The wealth of blood vessels probably accounts for this. All authors are agreed that the microscopic evidence of tuberculosis is exceedingly atypical and that careful search must be made before tubercles and foci of tuberculous granulation tissue are discovered. In some cases only the identification of the organism makes the diagnosis certain. In our case giant cells were scanty but typical foci of tuberculous granulation tissue were much in evidence beneath the serosa and in the submucosa. The diffuse cellular nature of the infiltration should not deceive one into calling the lesion sarcomatous.

Hyperplastic tuberculosis is not only confined to the intestinal canal but is seen occasionally in serous membranes in the larynx and in lymph nodes. In the latter situation it may resemble Hodgkin's disease so closely that only the discovery of the bacilli of tuberculosis serves to make the diagnosis. Hyperplastic tuberculosis of the small intestine occurring in conjunction with cecal tuberculosis is uncommon (2, 11, 30), but as a single isolated lesion it appears to be exceedingly rare. Kaufmann apparently grouped it with the stenosing and cicatricial type of tuberculosis of the small intestine. It is scarcely mentioned in the extensive monograph of Huebschmann. The following is quoted from Lartigau:

Hyperplastic tuberculosis of the small intestine is rare. Here it is not so often a ques-

tion of those large tumor masses so easily taken for carcinoma, the growth is ordinarily more limited and less voluminous. Nevertheless the other features of the pathological and clinical picture are present, even more complete stenosis has been observed. Although the lesion of the small intestine may exist without cæcal disease it is oftener found that the two are concomitant. In a few instances, however, the hyperplastic tuberculous disease has been confined to the ileum, the part near the cæcal end being affected."

Lartigau could find only 2 cases of this disease limited to the small bowel. In 1 case, reported by Pantaloni, there was isolated involvement of the ileum for a distance of 12 centimeters and the caliber of the bowel was reduced to half its former size. The other case, that of a girl aged 17 years, was reported by Guinard. There were four regions of stenosis which had produced marked obstruction for 15 years. The small intestine proximal to the obstruction was dilated to a size resembling that of the stomach. Extensive resection was performed and the patient recovered. The condition of the obstructed intestine must have been similar to that in our case. The third case was reported by Soubeyran. It occurred in a woman aged 25 years. The lesion involved 9 centimeters of the ileum and death occurred 19 days after resection. Michon reported a case in which the condition existed in the terminal 5 centimeters of the ileum, unaccompanied by any cæcal disease but with markedly enlarged mesenteric lymph nodes. The patient, a woman aged 26 years, presented the signs and symptoms of acute appendicitis and for this reason was subjected to exploration. The tumor was resected without difficulty and lateral anastomosis between the terminal portion of the ileum and ascending colon was performed. The patient recovered. Ransohoff reported the fifth example of the condition, the patient was a boy aged 9 years, tuberculous cervical lymph nodes had been removed in the previous year. This case is of considerable interest because of the situation of the lesion and the presence of active tuberculosis elsewhere. The lower part of the jejunum was involved for a distance of

17.5 centimeters and the regional lymph nodes were also involved. Resection and end to end anastomosis were performed, and recovery ensued.

The sixth case was reported by Lstor, Grynfeldt, and Aimes. A localized cancer like mass was found in the terminal portion of the ileum of a woman aged 35 years. It had produced obstructive symptoms for some time previously, and at operation the proximal part of the ileum was found to be markedly dilated but not hypertrophied. The tumor and the enlarged regional lymph nodes were resected, the impression was that the lesion was carcinomatous, but pathological examination showed it to be an example of hyperplastic tuberculosis. This was the only evidence of active tuberculosis presented by the patient. Recovery was complete.

In our case, the seventh on record, other active foci of tuberculosis were not discovered after careful clinical investigation. Roentgenograms of the chest repeatedly gave negative results. Although it is not possible to state whether the intestinal lesion was due to a primary or to a secondary infection, it is certain that at the time of its removal it represented the only active focus of clinical significance. In view of its long duration in the bowel, it is not surprising that the mesenteric lymph nodes were calcified, and for this reason it appeared safe to leave them *in situ*. Gross and microscopic examination of the resected specimen proved it to be a typical example of true hyperplastic tuberculosis. The pathological features of this disease already have been discussed, attention should be called, however, to the gross resemblance of the lesion to carcinoma and to the superficial microscopic resemblance to lymphosarcoma.

**Symptoms.** As the progress of such a lesion is toward obstruction of the bowel, it is not surprising that the symptoms are practically identical with those already enumerated as arising from a paraduodenal hernia. Koenig summed them up in the syndrome of "ballooning of the intestines, visible peristalsis, clapping, borborygmi accompanying the colic and with the appearance of an elongated tumefaction." Here the symp-

toms were no doubt due to the tuberculosis rather than to the hernia.

**Treatment** In none of the cases, with the exception of that reported by Ransohoff, did there appear to be active tuberculosis elsewhere. Whether one regards the hyperplastic infection as primary or secondary, it is the rule that the co-existing tuberculosis in other parts of the body is not clinically significant. Radical resection of the affected segment is, therefore, the operation of choice and intestinal anastomosis is carried out by the most suitable method. In the small intestine this is practically always possible, because of the mobility of the lesions and their freedom from adhesions. If radical excision is impossible, lateral anastomosis between afferent and efferent loops may be performed. Erdman believes that ileostomy in the afferent loop should be considered only as a last resort. The insertion of an enterostomy tube into the afferent loop by the Witzel method is however a wise precaution if the condition of the obstructed bowel warrants it.

#### THE RELATIONSHIP OF THE TWO LESIONS IN THE CASE REPORTED

The isolated tumor found in the ileum and considered to be the actual cause of the enormous dilatation and hypertrophy of the herniated bowel proved after resection to represent a typical example of chronic hyperplastic tuberculosis which when it occurs in the cæcum is known as 'ileocæcal tumor' (Duranti) typhlitis resembling cancer (Hartmann) or the 'real surgical tuberculosis of the cæcum' (Berard). Suspicion of its true nature was not entertained at the time of removal and it was considered to be either a chronic inflammatory process due to some intrahernial abnormality or possibly a scirrhous carcinoma of the small intestine. Even the presence of several calcified mesenteric lymph nodes as large as 2 centimeters in diameter did not impress one with the possibility of active tuberculosis in the wall of the bowel, a common condition in civilized native races. These calcified nodes were thought to represent old healed tuberculous infection of childhood. Furthermore the fact that the

tumor was small, annular, single, and situated at least 120 centimeters from a perfectly normal cæcum, appeared to make the diagnosis of tuberculosis highly improbable. Examination of the gastro-intestinal tract, from the stomach to the sigmoid, showed only one such lesion to be present. The definite possibility of carcinoma and the obvious obstruction produced by the lesion led to its removal and pathological examination. This was done only after due consideration of the added risk to the patient.

Just why two such exceedingly uncommon pathological conditions should occur together is not at first sight clear. A consideration of their etiology, however, affords what is probably the most rational explanation and supports the view that it was something more than mere coincidence. As has been pointed out, paraduodenal hernia is frequently devoid of symptoms and may exist throughout the lifetime of the patient without causing suspicion of its presence. Whether clinical symptoms are produced or not, however, a hernial sac of such proportions constitutes an ideal situation for the development of intestinal stasis. It has long been known that the reason for the occurrence of hyperplastic tuberculosis at or near the ileocæcal valve and in the rectum is due to the marked slowing of the intestinal stream in these regions. The bacilli of tuberculosis are here enabled to gain a foothold in the mucosa. Without a primary focus in the cæcum there is little chance for this to occur normally in the small intestine. In this patient no doubt the hernia provided the region of ileal stagnation with resulting tuberculous infection. Parallel examples are to be seen in the occurrence of tuberculosis in a Meckel's diverticulum. Coley (7) reported such a case and reviewed 9 others from the literature. Here again stagnation of food in the diverticulum no doubt accounted for the tuberculous infection of the wall. The condition of the afferent loops of intestine and the character of the obstruction leave little doubt in our minds that the majority if not all of the symptoms from which the patient suffered were due to the tuberculosis and not to the hernia.

# SUMMARY

A case is reported of right paraduodenal hernia in association with marked obstruction of the herniated small intestine due to an isolated tumor resembling carcinoma but of hyperplastic tuberculous origin

This is the thirty third example of right paraduodenal hernia reported, the sixteenth patient with this condition to be operated upon, and the fifth to recover following operation. Isolated hyperplastic tuberculosis of the small intestine is rare, only 7 cases have been reported. The two lesions in association make the case unique. A discussion of the clinical and pathological features of each condition is given.

The presence of tuberculosis in the hernial sac is interpreted as being due to stagnation of food and to the slowing of the intestinal current in the sac. The conditions were thus similar to those under which the same type of tuberculosis occurs in the cæcum.

# BIBLIOGRAPHY

- 1 ANDREWS EDWARD Duodenal hernia a misnomer Surg Gynec & Obst 1923 xxxvii 740-750
- 2 BERGER Discussion Bull et mém Soc de chir de Par 1906 xxvii 845
- 3 BERNARDREIG J Étranglement de la totalité de l'intestin grêle dans une hernia paraduodénale droite Bull et mém Soc nat de chir 1925 li 284-287
- 4 BROUARDEL GILBERT A. and CARNOT P Nouveau traité de médecine et de thérapeutique Maladies de l'intestin xviii Paris J B Baillière et fils 1921
- 5 BROWN F R Right duodenal hernia with report of a case successfully operated on the fourth recorded recovery Brit J Surg 1923 xiii 357-376
- 6 CALMETTE ALBERT Tubercle bacillus infection and tuberculosis in man and animals Baltimore Williams and Wilkins Company 1923
- 7 COLEY B L Tuberculosis of Meckel's diverticulum associated with tuberculous appendix Arch Surg 1923 vi 519-528
- 8 Idem Strangulated left duodenal hernia report of a case with recovery Arch Surg 1929 xviii 868-881

- 9 CONRATH V Ueber die lokale chronische Coecum tuberkulose und ihre chirurgische Behandlung Beitr z klin Chir 1893, xxi 1-110
- 10 DESJARDINS A V Left paraduodenal hernia Ann Surg 1918 lxvii 195-201
- 11 ERDMAN SEWARD Hyperplastic tuberculosis of the intestines Ann Surg 1920, lxxi 637-647
- 12 ESTOR F GRYNFELT E and AINIS A Sténose iléale tuberculeuse Montpel méd, 1921 xliii 18-20
- 13 GUYARD Rétrécissements tuberculeux de l'intestin Bull et mém Soc de chir de Par 1899 xxi 32, 338
- 14 HARTMANN HENRI and PILLIST A II Note sur une variété de typhlite tuberculeuse simulant les cancers de la région Bull Soc anal de Par 1901 lxvi 471-476
- 15 HUESCHMANN PALL Pathologische Anatomie der Tuberkulose Berlin Julius Springer, 1923
- 16 KAUFMANN EDUARD Lehrbuch der speziellen pathologischen Anatomie fuer Studierende und Aerzte 2 vols Berlin G Reimer 1911
- 17 KOENIG F Die stricturnende Tuberkulose der Darnies und ihre Behandlung Deutsche Zeitschr f Chir 1892 xxxiv 65-81
- 18 LARTIGAU A J A study of chronic hyperplastic tuberculosis of the intestine with report of a case J Exper M 1901-1905 vi, 23-51
- 19 LOCKHART MUMFERY PERCY Diseases of the rectum and colon and their surgical treatment London Baillière Tindall and Cox 1923
- 20 MOVVINHAN B G A Retroperitoneal hernia London Baillière Tindall and Cox 1906
- 21 MUELLER Quoted by Brown
- 22 MICHON Tuberculose hypertrophique de la partie terminale de l'iléon Bull et mém Soc de Chir de Par 1906 xxxii 840-845
- 23 NAGEL G W Right paraduodenal hernia Tr Am M Ass Sect Obst Gynec and Abdominal Surg 1923 137-152
- 24 NOVAK EMIL and SLESSMAN A A Right paraduodenal hernia, recovery after operation (the third in medical literature) J Am M Ass 1924 lxxxii 1664-1666
- 25 PANTALONI Quoted by Lartigau
- 26 PATON Quoted by Brown
- 27 RANVIN F W Surgery of the colon New York D Appleton and Company 1926
- 28 RANSOHOFF J Hyperplastic tuberculosis of the small intestine Ann Surg 1920 lxxii 196-190
- 29 ROQUE IATEL and MORENAS Rétrécissement cicatriciel tuberculeux du grêle Guérison par entérectomie Lyon méd 1924 cxxxiv 394-396
- 30 ROUTIER Discussion Bull et mém Soc de chir de Par 1906 xxxii 841-845
- 31 SESTRAUK W F Personal communication
- 32 SOUBEYRAN P Tuberculose de l'intestin grêle à forme hypertrophique Montpel méd 1902 xvi 4, 0-47

THE EFFICIENCY OF CHOLECYSTENTEROSTOMY ON THE BILIARY TRACT<sup>1</sup>

CATEWOOD M.D. I.A.C.S. AND STANLEY I. LAWTON M.D. CHICAGO

ANASTOMOSIS of the biliary tract to the intestinal tract has been discussed extensively in the literature during the past few years. There is still much difference of opinion about the type of operation to be done and the indications for such operations. In 1922 Poppens and one of us (2) reviewed the literature and reported the results of our experiments on a series of 42 dogs. We came to the conclusion that from an experimental standpoint infection of the liver and biliary tracts invariably follows cholecystenterostomy. Since then, a number of others (Horsley, Lehman, Beaver) have repeated these experiments, and without exception have arrived at the same conclusions. Nevertheless Wangensteen concludes that in man evidence of infection after anastomosis of the gall bladder to the stomach rarely occurs. Ladd, in 1928, reported three successful cholecystoduodenostomies and one cholecystogastrostomy done in children for relief of congenital stenosis or atresia of the ducts. In a personal communication, he states that "as far as we know these children who have cholecystenterostomies do not have hepatitis or cholangitis as a sequel to the operation." Lowenstein reported 9 cases in which operation was done from 1 to 9 years previously without clinical evidence of infection, and Hans Kehr, who has championed this operation and has performed it more than sixty times, feels that hepatic infection is rare. Recently, Walters reported 8 cases in which anastomosis of the gall bladder or common duct to the stomach or duodenum had been done. Six patients survived. Four of these patients are clinically well. Judd, in 1928, reported the only postmortem results we have been able to find. Although this patient was clinically well, autopsy revealed multiple liver abscesses. Beaver states<sup>3</sup> that he knows of one other similar case in which marked evidences of liver infection were found at autopsy.

A review of our hospital records adds little to the solution of the problem. Anastomoses between the gastro-intestinal and biliary tracts have been done only for very definite indications, such as obstruction of the common duct due to carcinoma of the pancreas or stricture. From our records of 23 cases, most of which have been done within the last 10 years, we find that several of our patients are clinically well some years after operation. Most of the patients operated upon for carcinoma died before one could obtain evidence of bile tract infection, although some of these patients were temporarily very materially improved. For example, Mr. F. L. (Hosp. No. 220539) upon whom we did a cholecystogastrostomy May 21, 1928, gained weight temporarily and was clinically much improved. His jaundice of almost 3 months standing completely disappeared after operation. He died 3 months later of carcinoma of the pancreas. Although patients may live a long time with no bile passing into the intestinal tract, there is no question about the physiological benefit of the bile on intestinal digestion, to say nothing of the additional comfort to the patient from internal drainage. Two of our patients (Mrs. M. R. Hosp. No. 203223, and Mrs. H. W., Hosp. No. 227613), who had choledochoduodenostomies performed 27 and 8 months ago for obstruction of the common duct, have been clinically well without evidence of infection. A third patient (Mrs. C. S., Hosp. No. 21028) was operated upon on April 8, 1927, for recurrent cholangitis due to a stricture of the hepatic duct. Following hepaticoduodenostomy she reports that she is much improved, although she continues to have an occasional attack of epigastric pain. There has been no jaundice, however. A fourth patient, Mrs. L. F., who had a cholecystogastrostomy performed for common duct obstruction by Dr. E. Wyllys Andrews in 1917, has been clinically well since. A recent fluoroscopic examination

<sup>1</sup> From a communication<sup>2</sup> in the Department of Surgery, R. A. Medical College of the University of Chicago, and Presbyterian Hospital, Chicago.

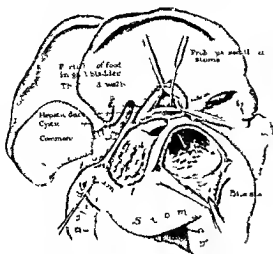


Fig 1 Dog 26 146 days Showing patent stoma and thickened gall bladder wall

enabled us to find no evidence of the stoma by the use of the barium meal. On the other hand, one of our patients (Mrs. K. C., Hosp. No. 132,577) lived 5 years with occasional attacks of jaundice, chills, and fever. Autopsy revealed marked inflammation of the ducts and also severe hepatitis and cirrhosis. Another (Mr. J. W., Hosp. No. 130015) who had a cholecystocolostomy, developed evidence of hepatic infection within a short time after operation. Both from a physiological and experimental standpoint anastomosis with the large bowel is unsound and rarely, if ever, indicated. We can find no case recorded in the Presbyterian Hospital since 1921.

As there is a growing tendency to perform cholecystenterostomy for a variety of pathological conditions, such as ulcer impacted common duct stones and chronic pancreatitis, it seemed to us worth while to find, if possible, some explanation for the differences between the clinical and the laboratory results and the following experiments, therefore, were undertaken.

#### EXPERIMENTAL STUDY

The experimental work was carried out on a series of 20 apparently normal healthy dogs weighing between 12 and 20 kilograms. As Beaver, Oddi and others have shown that the presence of bile in the stomach in no way



Fig. 2 Dog 34 0 days Chronic inflammation of common duct showing round cell infiltration among muscle bundles

affects gastric digestion and as the stomach seems to be the most logical viscus to employ, all anastomoses were made between it and the gall bladder. Under ether anaesthesia and by strictly aseptic technique, cholecystogastrostomy was performed, in much the same manner as a gastroenterostomy is done,

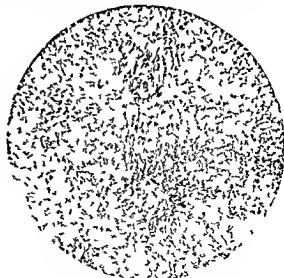


Fig 3 Dog 1 51 days Liver showing slight round cell infiltration. Otherwise normal



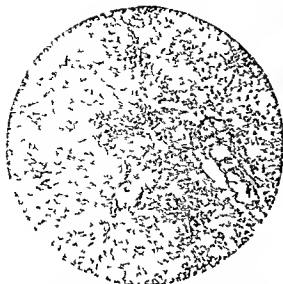


Fig 4 Dog 8 30 days Chronic retrogressive changes about central lobules Ascending perportal lymphangitis

two rows of fine silk suture being used to make the anastomosis. The site selected for anastomosis was about 3 centimeters above the pyloric ring and somewhat nearer the lesser than the greater curvature of the stomach. When completed, the lumen established between the stomach and gall bladder measured about 0.5 centimeter in diameter. Little difficulty was experienced in approximating the stomach and gall bladder and no undue tension resulted. The common duct was explored for signs of obstruction and in all dogs was apparently normal. The common duct was allowed to remain in its normal condition and was not ligated or obstructed. After sufficient time had elapsed for complete recovery from operation and healing of the abdominal wound the dog's abdomen was again opened, cultures made from the liver, gall bladder and common duct and sections removed for microscopic study. Fifteen days after operation 4 dogs developed symptoms in an epidemic distemper and were killed for examination at that time. Sixteen dogs were examined at various intervals of from 21 to 146 days after operation.

**Results** All dogs recovered from operation. With the exception of the 4 which developed distemper, all dogs were apparently in good



Fig 5 Dog 31 A 150 days Showing results obtained in previous series when common duct was ligated. Note numerous round worms extending into the hepatic ducts.

health at the time they were sacrificed. In every instance evidence of disease was absent in the gross specimens of the liver, stomach, and common duct. The gall bladder mucosa were thickened without exception (Fig 1). Microscopic examination revealed pathological change in all livers and gall bladders. A few of the common ducts showed slight round cell infiltration (Fig 2). In the livers the changes varied from a slight round cell infiltration to an ascending perportal lymphangitis with acute and chronic retrogressive changes about the central liver lobules (Figs 3 and 4). The gall bladders showed varying degrees of round cell infiltration and thickening of the mucosa. Bacteriological examinations showed that the results were uniform throughout. Smears and cultures of the livers were all negative. In smears of gall bladder bile and common duct bile many large Gram negative rods and few Gram positive rods were present. Cultures showed bacillus coli communis and bacillus proteus vulgaris present.

#### DISCUSSION

The results of this series of experiments show again that infection of the gall bladder, liver and bile tracts follows cholecystogastrostomy in dogs. In this series as contrasted to our previous series in which the common ducts were ligated and divided there is no dilatation of the common ducts and no

SERIES I OPERATION CHOLECYSTOGASTROSTOMY ON LESSER CURVATURE OF STOMACH  
COMMON DUCT NOT OBSTRUCTED

No	Days lived after operation	Symptoms Cause of death	Pathology		Bacteriology	
			Gross	Microscopic	Smears	Cultures
7	15	Nasal discharge Killed	Liver—no changes Gall bladder—mucosa thickened Common duct—normal	Liver—acute retrogressive changes especially about the central lobules Gall bladder—mucosa thickened with slight round cell infiltration	Liver—negative Gall bladder—large gram+ rods Common duct—few large gram— rods	Liver—negative Gall bladder—bacillus coli communis Common duct—bacillus coli communis
28	30	Killed	Liver—no changes Gall bladder—distended with thick muddy bile. Wall thickened in places chronically inflamed Common duct—normal	Liver—chronic retrogressive changes about central lobules. Ascending lymphangitis about portal canals and veins Gall bladder—mucosa thickened, marked round cell infiltration	Liver—negative Gall bladder—many large gram+ rods, few large gram— rods Common duct—few large gram+ rods	Liver—negative Gall bladder—bacillus coli communis, bacillus proteus vulgaris Common duct—bacillus coli communis
1	54	Killed	Liver—no changes Gall bladder—mucosa slightly thickened. Bile thin clear Common duct—normal	Liver—slight round cell infiltration otherwise normal Gall bladder—slight round cell infiltration	Liver—negative Gall bladder—few gram+ rods Common duct—few gram— rods	Liver—negative Gall bladder—bacillus coli communis Common duct—bacillus coli communis
34	70	Killed	Liver—small yellow areas on upper surface of middle lobe Gall bladder—wall thickened, distended with thick bile. Mucosa chronically inflamed Common duct—normal	Liver—small amount of round cell infiltration with increased fibrous connective tissue Gall bladder—mucosa thickened infiltrated with round cells Common duct—slight round cell infiltration	Liver—negative Gall bladder—large gram+ rods Common duct—large gram— rods	Liver—negative Gall bladder—bacillus coli communis Common duct—bacillus coli communis
3	90	Killed	Liver—normal few adhesions to diaphragm at site of anastomosis Gall bladder—distended with thick muddy bile. Wall and mucosa thickened. Many adhesions Common duct—normal	Liver—chronic retrogressive changes with small amount of periportal round cell infiltration Gall bladder—mucosa thickened small amount of round cell infiltration Common duct—normal	Liver—negative Gall bladder—large gram+ rods Common duct—large gram— rods	Liver—negative Gall bladder—bacillus coli communis Common duct—bacillus coli communis
16	146	Killed	Liver—normal Gall bladder—bile thin clear. Wall about normal thickness. Mucosa very slightly thickened Common duct—normal	Liver—slightly increased fibrous tissue with small amount of round cell infiltration Gall bladder—slight round cell infiltration Common duct—normal	Liver—negative Gall bladder—large gram+ rods Common duct—large gram— rods	Liver—negative Gall bladder—bacillus coli communis Common duct—bacillus coli communis

evidence of gross food particles or round worms in the lumina (Fig 5). Infection is definitely less when the common duct is not ligated and divided. Such experimental differences suggest the following possible explanations for the differences between laboratory and clinical findings.

1 Since the most uniformly satisfactory results have been obtained in cases of pancreatitis, is it not likely that most of the bile soon passes into the duodenum by the normal route and that there is very little retention of foreign material in the gall bladder? From two of our previous experiments and from the work of Lehman, we had been led to believe that the stoma of a cholecystogastrostomy would close in the absence of common duct

obstruction. While in our present series of experiments the stomata remained patent, the tendency undoubtedly is for contraction. In some of our dogs, the gastric rugæ acted almost like a valve and probably partially protected the gall bladder from extraneous material. In Dr Andrew's patient every attempt to visualize the gall bladder by pushing barium into it from the stomach was unsuccessful.

2 Many animals which were apparently healthy when sacrificed showed very definite bacteriological and microscopic evidence of hepatic infection. May there not be silent hepatitis in many of the patients who are clinically well? The postmortem findings in Dr Judd's case would lend plausibility to this

theory. More autopsy data will probably settle this question.

3 Finally may it not be possible that the human liver is better able to conquer biliary infection than that of the dog? It is well known that fat metabolism differs materially in the two.

#### CONCLUSIONS

1 From an experimental standpoint infection of the gall bladder invariably follows cholecystogastrostomy regardless of obstruction of the common duct. The anastomotic stomata remain patent at least 146 days.

2 Hepatitis and cholangitis are the rule in cholecystogastrostomy but not to as marked a degree as in a previous series in which the common duct was ligated and divided.

3 Until better proof is obtained that the conditions in man are not paralleled in the experimental animal, we must conclude that anastomoses between the biliary and gastrointestinal tracts are not without danger of ascending biliary infection. While oftentimes a life saving measure such anastomoses should

not be done for other than the most definite indications.

#### BIBLIOGRAPHY

- 1 BEAVER MEREDITH G. Cholecystogastrostomy an experimental study. Arch Surg. 1929 xviii 899.
- 2 GATEWOOD and POPPENS PETER. Cholecystenterostomy from an experimental standpoint. Surg Gynec. & Obst. 1922 xxxv 445-452.
- 3 HORSLEY J S Jr. Experimental study of cholecystogastrostomy and cholecystoduodenostomy. South M J. 1924, xx 669.
- 4 JUDD E STARR. Side tracking' operation in obstructive jaundice. J Am M Ass. 1928 xci 300.
- 5 KEHR H. Chirurgie der Gallenwege. Neue Deutsch. Chir. 1913 viii 628.
- 6 JUDD WILLIAM E. Congenital atresia and stenosis of the bile ducts. J Am M Ass. 1928 xci 1082.
- 7 LEHMAN E P. Hepatitis following cholecystogastrostomy. Arch Surg. 1924, ix, 16.
- 8 LOWENSTEIN KURT. Cholecystoduodenostomy as operation of choice in obstructive lesions of common bile duct. Arch f klin Chir. 1927 cxliii 655-663.
- 9 ODDI ROGERO. Action de la bile sur la digestion gastrique étudiée au moyen de la fistule colico-gastrique. Arch ital de biol. 1888 ix 138.
- 10 WALTERS WALTMAN. Relief of obstructive jaundice from tumors in the head of the pancreas. Ann Surg. 1929 lxxvix 23.
- 11 WANGENSTEEN O H. Cholangitis following cholecystenterostomy. Ann Surg. 1928 lxxvii 34.

## POSTOPERATIVE PULMONARY ATELECTASIS

REPORT OF AN UNUSUAL CASE<sup>1</sup>

RICHARD H. OVERHOLT, M.D., EUGENE P. PENDERGRASS, M.D., AND SIMONS LEOPOLD, M.D., PHILADELPHIA

THERE appeared in 1850 a treatise by Sir William Fennant Gardner on the consequences of bronchitis in which he described pulmonary collapse. In 1908 William Pasteur called attention to the occurrence of massive collapse as a postoperative complication having previously observed this condition in postdiphtheritic paralysis of the diaphragm. In the next 17 years, according to Scott's published statistics, only 68 cases of postoperative massive pulmonary collapse were recorded in the literature. Since 1925 there has been a veritable flood of contributions concerning its symptoms, physical signs, roentgenological findings and the mechanism of its production. Recently Bowen (1) has reviewed the subject comprehensively and has provided a complete bibliography.

The greatest interest in this condition has centered around the problem of the means whereby massive pulmonary atelectasis is produced. Bronchial occlusion followed by absorption of the imprisoned air has been clearly shown to result in an apneumatois or atelectasis of the pulmonary tissue involved. Experimentally as early as 1879 atelectasis was produced in rabbits by occluding the bronchi (2). In 1924, prior to the appearance of any published reports of a bronchoscopic examination during the course of this disease, one of us (2) stated the following: 'If bronchoscopic examination during a collapse attack will demonstrate bronchial obstruction in the bronchus supplying the collapsed and drowned lung then this explanation would seem correct for those cases which occur postoperatively.' Coryllos and Birnbaum have recently confirmed this conception experimentally using obstructing balloons in the bronchi of dogs. Lee Ravdin, Tucker and Pendergrass have transferred, by means of

a bronchoscope obstructing mucus from a human affected with atelectasis to an animal and have produced the condition. However Bradford in discussing massive collapse of the lung attempts to explain it on a neurogenic basis. He states that it is "an unusual condition in which the lung without the presence of any gross lesion such as bronchial obstruction, pleural effusion, etc., interfering with the free entry of air, becomes useless to a greater or less degree." Bradford cites cases of traumatic origin, wounds of the buttocks, pelvis and thighs or abdominal wall, in which massive pulmonary collapse occurred. Elkin (7) reports a case which followed fracture of the tibia. There have been other references to a non obstructive type of pulmonary collapse so that the question of causation in all cases is not definitely established.

Many of those interested in the clinical study of postoperative pulmonary atelectasis have been impressed with the extraordinary density of the shadow produced on the roentgenogram by the involved lung. This is frequently so dense that the rib shadows are obscured. This fact has been commented upon by Scrimger, Sante (17), and Leopold (12).

Explanations for the extreme density, however, have not been discussed by many writers. We have recently had the opportunity to study an interesting case of massive atelectasis in which this particular phase of the condition presented some unusual features.

In conjunction with a study directed by Dr. George P. Muller, covering pulmonary complications following abdominal operations, the patient whose history follows was observed prior to and after operation during the pre-atelectatic stage, during collapse attack, and in the course of subsidence of pulmonary signs.

Mrs. L. M. aged 24 years was admitted on November 20, 1928 to the University of Pennsylvania Hospital on the service of Dr. George P. Muller. The history was of 3 months duration and

<sup>1</sup> Girdin was probably the first to recognize pulmonary collapse in the adult and to relate it to bronchial obstruction. Writers on this subject differed as to the mechanism and the clinical picture. It is interesting to note that the origin of the condition is often stated to be in the early days of the condition. The term atelectasis and its etiology is often stated to be in the early days of the condition.

From the University of Pennsylvania and the Departments of Roentgenology and Medicine of the University of Pennsylvania Hospital. Presented before the Philadelphia Roentgen Ray Society, December 6, 1928.

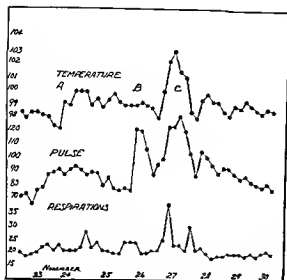


Fig. 1. Clinical chart showing temperature, pulse and respiratory rate. A Time of operation. B Time that marked mediastinal shift was recorded (Fig. 3). Note the pulse rise at this time. C Time of the appearance of roentgenographic density (Fig. 4). Note the sharp temperature reaction at this time only.

the symptoms were those typical of gall bladder disease. There were no pulmonary symptoms. The history was otherwise irrelevant as were also the medical family and social histories. The patient was a well nourished young woman who grossly showed no evidence of any disease. Physical examination revealed nothing except some tenderness over the gall bladder area. Routine blood and urine studies were negative. Cholecystographic studies were made and the diagnosis of gall bladder disease was substantiated. The roentgen examination of the chest was negative.

On November 24 operation was performed by Dr. Muller. Under ether anaesthesia the abdomen was opened through a transverse incision. Chronic calculous cholecystitis was found and a cholecystectomy and appendectomy were performed. The procedure was not particularly difficult and the intra-abdominal trauma was minimal.

The immediate postoperative reaction was slight. For 36 hours there were no symptoms or signs referable to the chest. On November 26, 48 hours after operation, the patient complained of a slight sense of pressure over the sternum and had an occasional cough without expectoration. There was no temperature elevation although the pulse was rapid. Examination of the chest showed limited expansion, slightly impaired resonance and markedly suppressed breath sounds over the entire right chest. Posteriorly over the right lower lobe there were distant tubular breath sounds.

Under the fluoroscope in the recumbent position it was noted that there was a marked displacement

of the mediastinum and heart to the right. Surprisingly, the right lung was practically clear. The right dome of the diaphragm was elevated and fixed and the inter rib spaces were narrowed. A bedside film was made and the fluoroscopic findings were confirmed. The roentgenologic diagnosis was massive atelectasis.

On the third day after operation (72 hours) there were no symptoms whatever, dyspnea cough and expectoration not being present. The patient chose to lie on the unaffected side. For the first time however she began to have a febrile reaction and in the afternoon the temperature had reached 103 degrees. The examination of the chest was essentially the same as on the previous day except for more marked tubular breathing over the right lower lobe and sounds which were approaching normal in the upper lobe.

Another roentgenogram was made and the findings this time were quite different from those on the previous examination recorded 24 hours before. There was a marked density of the right middle and lower lobes and the mediastinal structures although slightly displaced, had largely returned to their normal positions. The roentgenological diagnosis at this time was massive atelectasis and drowned lung.

As soon as the diagnosis of atelectasis was definitely established the patient was put down flat in bed and rolled from side to side and the affected side slapped as suggested by Sante (21). Coughing was not produced nor was any sputum raised. The temperature fell, however and was practically normal for the remainder of her convalescence.

On the fourth postoperative day (November 28) the patient was likewise symptomless and the physical signs were less in evidence. Over the right base posteriorly there were suppressed breath sounds of a bronchial type. No rales were heard. The roentgenogram at this time showed that the increased density of the right middle and lower lobes had largely disappeared, only some increased prominence of the trunk shadows remaining. There was no displacement of the mediastinal structures.

The remainder of the convalescence was uneventful all of the physical signs in the chest having disappeared by the fifth postoperative day. A slight cough was present on the following day and on two occasions was productive of a small amount of sputum.

The vital capacity determinations were made pre-operatively and throughout the period of convalescence. The initial vital capacity was found in this case to be 2600 cubic centimeters. After operation it fell to 600 cubic centimeters which represented a 77 per cent drop. This record closely corresponds to those made by one of us (14) after gall bladder and gastric operations upon patients in whom no pulmonary complications



Fig. Roentgenogram of patient made 24 hours before operation showing normal relationship of the domes of the diaphragm, intercostal spaces and mediastinal structures. This picture was made with the patient in the erect posture, the film being anterior.

Fig. 3. Roentgenogram of patient made 48 hours after operation showing almost complete atelectasis of the right lung with only slight haziness. The displacement of the mediastinal structures and the elevation of the right dome of the diaphragm and the narrowing of the intercostal spaces were most marked at this time. At the roentgenoscopic examination the right dome of the diaphragm was fixed. Bedside examination, the film placed posteriorly.

were found. In a series of 25 cases the vital capacity after operation averaged 33 per cent of the pre-operative record. Churchill and McNeil and Powers have reported similar reductions in the vital capacity after upper abdominal operations. It is surprising that in this case the diminution in vital capacity was recorded 24 hours after operation and not at the time the complete collapse took place, 48 hours later.

#### COMMENT

The features presented in this case, which are worthy of particular comment, are as follows:

1. The most marked displacement of the mediastinal structures to the affected side together with the greatest amount of elevation of the diaphragm occurred at the time when there was only very little increased density of the right lung.

2. The partial return of the mediastinal structures toward their normal position 24 hours later was observed at the time when

there was the maximum degree of density of the right middle and lower lobes.

3. There was no elevation of temperature at the time of the most marked atelectasis, and the subsequent presence and subsidence of fever coincided with the appearance and disappearance of the lung density.

4. The usual clinical symptoms of a pulmonary complication—cough, dyspnea and expectoration—were conspicuously insignificant. These phenomena will be discussed in the following paragraphs in the order detailed above.

All of the cases of postoperative massive pulmonary atelectasis which are recorded in the literature exhibit on the first roentgenogram after the collapse attack, extreme density of the affected lung and maximum mediastinal displacement toward the affected side.

We were unable to find a single case in which postoperative massive atelectasis had occurred and been so diagnosed in the absence of gross

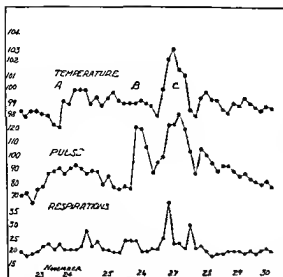


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of secretion which Lee and Tucker subsequently observed during bronchoscopic aspiration in a collapse attack and the equally abundant expectoration which frequently occurs spontaneously prior to re expansion of the affected lung would seem to justify this original conception. That retained secretions account for some of the extraordinary density is reasonably sure, that they do not explain the picture entirely is equally obvious when it is remembered that neither massive pneumonia, in which the bronchioles and alveoli are filled with exudates, nor large empyemata, obscure the rib shadows so completely. In discussing this subject with Bowen (2) he stated that Sante has considered engorgement of the pulmonary vascular system a possible reason for the lung density. Bowen agrees with this explanation and is of the opinion that the engorgement of the pulmonary vascular system results from an increase in negative intrathoracic pressure on the affected side.

The intrapleural negative pressure increases as the volume of the affected lung diminishes, Elkin (7) and Hablston have recorded high negative intrapleural pressure readings in cases of massive atelectasis. Clinically, this altered intrapleural negative pressure produces diaphragmatic elevation, diminished intercostal spaces, shifting of the mediastinal structures to the affected side and compensatory hyperaeration (not emphysema) of the unaffected lobes.

If the increase in the negative intrapleural pressure can produce these changes, it is plausible to suppose that engorgement of the pulmonary vascular system would readily occur.

While it is probable that engorgement of the pulmonary vascular system occurs for the reason above stated it cannot alone be responsible for the extreme density of the affected lung because the heart, thick walled and filled with blood, is less dense than the usual pulmonary shadow.

#### SUMMARY AND CONCLUSIONS

Fully cognizant of the fact that we are adding together some fact and much theory in an attempt to explain this unusual case, we offer the following conclusions

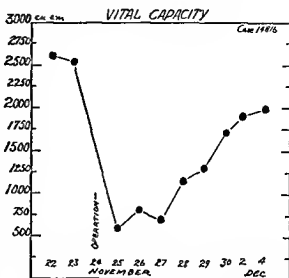


Fig 6 Graph showing vital capacity readings made before and after operation. The ordinary clinical spirometer was used. The highest of three tests was recorded in each instance.

1 The first roentgenogram made after operation is an example of pulmonary atelectasis despite the absence of extreme roentgenographic density characteristic of this disease.

2 The slight haziness of the affected lung is due to atelectasis and vascular engorgement of the pulmonary vessels, produced by an increased intrapleural negative pressure. Of all of the compensatory mechanisms reacting to increased intrathoracic, negative pressure, one would expect that vascular engorgement would be the first to respond. That increased negative intrathoracic pressure exists is evidenced by mediastinal displacement, diaphragmatic elevation, and narrowed inter rib spaces.

3 The usual picture of massive atelectasis results from retained secretions in the affected lung (drowned lung) plus vascular engorgement.

4 No explanation is offered for the fact that at the time of the maximum lung density, the mediastinal structures had partially returned to their normal position, unless we assume that in Figure 3 the entire right lung was atelectatic and that in Figure 4 the right upper lobe had re expanded. Were this the case, the reduction in the amount of negative pressure, incident to the re expansion of the





Fig 4 Roentgenogram made 72 hours after operation showing marked increased density of the lower portion of the right lung due to atelectasis and drowned lung involving the right lower and middle lobes. Note that the heart has returned almost to its normal position. Bedside examination.



Fig 5 Roentgenogram made 96 hours after operation shows that the density in the right lung has almost completely disappeared. The domes of the diaphragm have a normal relationship and the heart is still slightly displaced toward the right. Bedside examination.

lung density. This fact makes it incumbent upon us to offer evidence in favor of our belief that the appearance demonstrated in Figure 3 is that of massive atelectasis. We, therefore, reviewed a number of roentgenograms of cases in which complete collapse of the lung had been produced by both artificial and pathological pneumothoraces. We found that the lung density was comparable in degree to the appearance demonstrated in Figure 3 and quite different from the dense shadow in Figure 4. Chizzoli has reported a case of bronchial obstruction due to a foreign body in which mediastinal displacement and a non-opaque lung were recorded on the roentgenogram. No mention was made of further studies so it is not known whether or not the transparency of the affected lobe was lost subsequently to be replaced by the usual extreme density of massive atelectasis.

It is probable that roentgenograms similar to Figure 3 have not previously been recorded for one of two reasons: namely that this stage does not occur at any time in every case, or

that when it does, the time between its occurrence and the subsequent appearance (Fig 4) is so short that it has been missed despite daily roentgenographic examination.

For these reasons we believe that the findings in this case justified the diagnosis of pulmonary atelectasis and that this would explain the mediastinal displacement.

Most writers interested in massive atelectasis have been perplexed by the extreme density of the affected lung and in this case its explanation is attended with the utmost difficulty because coincident with its partial replacement of the mediastinal structures has occurred. A probable explanation for the extreme density is the retention of secretions in the obstructed lung after absorption of the imprisoned air. One of us (12) in 1941 entitled his first contribution to this subject, 'Postoperative Massive Pulmonary Collapse and Drowned Lung' believing that retained secretions must be present within the collapsed lung to account for the extraordinary density on the roentgenogram. The large outpouring

CHOLELITHIASIS IN THE KOREAN<sup>1</sup>

A I LUDLOW M.D. FACS SEOUL, CHOSŬN (Korea)

Mayo Foundation Lecture January 24 1928

ONE of the aims of the physician in Korea is to investigate the medical problem of a people that differ in diet, customs, and habits from people in other countries. Much has been written in America and Europe on the subject of gall stones, but so far as I am aware no report has been published concerning the incidence of cholelithiasis among Koreans.

## HISTORICAL REFERENCE

The Tong Wee Paw Kam, "A Valuable Treatise on Oriental Medicine," was written in 1777 A.D., at the request of the king by a Korean named Haw Choon. This book is regarded by native doctors as a most reliable source of medical and surgical information. The only statement found in this book concerning the gall bladder is that "the organ is related to the lung in function but has no outlet." Inasmuch as in former times there were no autopsies or dissections in Korea, human gall stones were obtained only when passed in the feces, but the organ in which they originated was unknown.

Koreans apply the term "In Whang," literally "Man Stone," to gall stones from the human body. The Koreans of olden times and some of the present day placed a high value upon the bile from the bear and considered the human gall stone as the most potent medicine known to man.

## INCIDENCE OF CHOLELITHIASIS

In 1912, when I first came to Korea, Eastern medicine was still in its initial stage. Statistics were fragmentary and had to be accepted with great caution. Under such circumstances, the question of the incidence of surgical diseases brought forth many conflicting opinions.

Appendicitis and cholelithiasis were conceded to be of infrequent occurrence. In the light of later experience, however, appendicitis was found to be fairly common. Rodman states: "Appendicitis is either on the increase in nearly every country and with every race

or its recognition has been made easier with both the profession and the laity." The latter part of Rodman's observation is true for Korea.

Cholelithiasis, on the other hand, seemed to show no increase in occurrence, although its recognition also should have been made easier with the advance of medical knowledge in Korea. In order to determine as accurately as possible whether or not the above impression was correct, a questionnaire was sent to physicians in charge of mission hospitals, located in all parts of the country. Replies were received from 12 hospitals. During the year 1925 there were 6,658 in patients and a total of 3,497 general operations of which 540 were laparotomies. Only 3 of these operations were for gall stones. Five of the doctors, who had been in Korea from 10 to 20 years, recorded a total of only 15 operations in which gall stones were found. Biggar, of Pyengyang, Korea, reported a case in which a gall stone, 5 centimeters in length and 2 centimeters in diameter, was found in the common duct. The stone was soft and broke while it was being removed. Imbedded in the center of the stone were two perfectly formed pine needles. The common duct also contained an ascaris.

Investigation was next made of our own records. The distribution of the cases of cholelithiasis in Severance Hospital, according to time, is indicated in Table I which gives the ratio of the number of cases of gall stones to the number of in patients, to the number of general operations, and to the number of laparotomies performed during the same periods.

Of the 8 patients reported in Table I, gall stones were found in 4 males (2 patients with stones in gall bladder and 2 with stones only in the common duct), and 4 females (1 with stones in the ducts of the gall bladder and in the liver, and 3 with stones only in the common duct). One of the last group of cases is worthy of special mention.

upper lobe, would lessen the degree of mediastinal displacement. Whether or not this actually occurred cannot be determined with certainty despite careful study of the roentgenograms.

5 The absence of fever at the time of the most marked atelectasis and its appearance coincident with the maximum lung density argues in favor of the contention of one of us (7) that fever and leucocytosis are brought about by the absorption of retained secretions.

6 The paucity of pulmonary symptoms, the absence of signs of pulmonary insufficiency and the lack of cough or sputum are most unusual but not unique. The absence of sputum is not necessarily a valid argument against our conception of the mechanism of this postoperative complication: bronchial obstruction, retained secretions, and drowned lung. It is probable that considerable absorption of exudates may occur in this condition, just as it does in lobar pneumonia in which complete lobar resolution may occur without any expectoration whatever.

#### BIBLIOGRAPHY

- 1 BOWEN DAVID R. Acute massive collapse (atelectasis) of the lung. *Am J Roentgenol & Radium Ther* 1921 **xxi** 101-141.
- BOWEN DAVID R. Personal communication.

- 3 BRADFORD SIR JOHN ROSE. *Oxford Med* 1920 **ii** 127.
- 4 CHIZZOLA G. Sulla sindrome radiologica dell'atelectasia polmonare da broncostenosi. *Arch d radiol* 1926 **iii** 113-121.
- 5 CHURCHILL E D and McNEIL D. The reduction in vital capacity following operation. *Surg Gynec & Obst* 1927 **xlv** 483.
- 6 COBYLLOS and BERNBAUM. Obstructive massive collapse of the lung. *Arch Surg* 1918 **xvi** 501-559.
- 7 ELKIN DAN C. Intrapleural pressure in postoperative atelectasis. *Ann Surg* 1927 **lxxxvi** 88.
- 8 GARDNER SIR WILLIAM TENNANT. Pathological states of the lung connected with bronchitis and bronchial obstruction. *Month J Med Sc*, 1850 **xi** 122, 230, 1851 **xii** 440, **xiii** 2, 238.
- 9 HAMILTON C C. Intrapleural pressures in massive collapse of lung. *Am J M Sc* 1928 **clxxvi** 831.
- 10 LEE, RAYMOND TUCKER and PENDERGRASS. Studies on experimental pulmonary atelectasis. *Ann Surg* 1928 **lxxxviii** 15-20.
- 11 LEE, W E and TUCKER G. Postoperative pulmonary atelectasis. *Atlantic M J* **xxii** 284-293.
- 12 LEOPOLD S S. Postoperative pulmonary collapse and drowned lung. *Am J M Sc* 1924 **clvii** 421.
- 13 LINTHGEN. Versuche ueber Lungenat elektase. *Arch f exper Path u Pharmacol* 1899 **x** 34.
- 14 OVERHOLT RICHARD H. Vital capacity studies. To be published.
- 15 PASTEUR SIR WILLIAM. Re piratory paralysis after diphtheria as a cause of pulmonary complications. *Am J M Sc* 1890 **c** 242, Massive collapse of the lung. *Lancet* 1908 **ii** 1351. Active lobar collapse of the lung after abdominal operations. *Lancet* 1910 **ii** 1080.
- 16 POWERS J H. Vital capacity. *Arch Surg* 1918 **xvi** 303-313.
- 17 SANTE L. Massive collapse of the lung. *Ann Surg* **lxxxviii** 161-177.
- 18 SCOTT W J M. Postoperative massive collapse of the lung. *Arch Surg* 1925 **x** 73-116.
- 19 SCHEIDTGER F A C. Postoperative massive collapse of the lung. *Surg Gynec & Obst* 1921, **xxxi** 486.

1925 was 21, among which no gall stones were found. Stearns, of Tsinan, found no case of gall stones among 1,450 in patients during the year 1925. From 1924 to 1926 inclusive, 76 autopsies were performed, about half the number being on children, and no case of gall stones was found.

Dunlap, of the Temple Hill Hospital, Chefoo, reported no case of gall stones among 650 in patients during the year 1925.

Hutcheson, of Nanking, among a total of 3,291 in patients at the University Hospital in 1925, stated that in 2 cases a diagnosis of gall stones was made but neither patient was operated upon. However, within the 3 months from January to March, 1927, he operated upon 2 patients with common duct stones.

Oldt, of the Canton Hospital, recorded only one case of gall stones during the years 1921 to 1923 inclusive, although there were 9,717 in patients and 5,545 general operations, of which 330 were laparotomies. It is of interest to note that 140 operations for vesical calculi were performed during this same period. No autopsies were reported by Oldt.

Hofmann, of the David Gregg Hospital (Women's Hospital), Canton, found no case of cholelithiasis among 2,600 in patients and 929 general operations, most of which were gynecological, though vesical calculi are common in this hospital. In 10 autopsies, no gall stones were found.

The statistics reported in Table III indicate that gall stones are very rare among the Chinese but the vast population of China, with its meager hospital facilities and comparatively few qualified physicians, would make it seem possible that the incidence of gall stones in the Chinese may be greater than is indicated by these statistics.

A comparison of the incidence of cholelithiasis among the Koreans with that among the people of other races is shown in Table IV.

The incidence of gall stones among the American in patients and among general operations is thirty times that found among Koreans but the incidence based on the number of laparotomies is only ten times greater among Americans than among Koreans.

Among all the above races combined, the percentage of gall stones is as follows. In

TABLE III—SUMMARY OF CLINICAL CASES OF CHOLELITHIASIS IN THE CHINESE

Year	Location of hospital	No cases of gall stones	No of hospital in patients	Per cent	No general operations	Per cent	No of laparotomies	Per cent
1925	Moukden	0	2,115		1,110		40	
1925	Peking	1	2,835	0.035	2,541	0.030	387	0.153
1925	Tsinan	0	1,450		580		32	
1925	Cheloo	0	650		330		28	
1925	Nanking	0	3,291		1,717		35	
1921-1925	Canton	1	9,719	0.010	5,545	0.018	330	0.303
1925	David Gregg Canton	0	2,600		929	0.00	?	
Total	7 hospitals	1	22,710	0.004	12,270	0.010	861	0.231

patients 0.535, general operations, 1.120, and laparotomies 6.170.

#### AUTOPSY INCIDENCE OF CHOLELITHIASIS AMONG THE KOREANS

No autopsies were reported from any of the mission hospitals in Korea outside of Seoul. In the Severance Union Medical College, from the year 1912 to 1926, inclusive, there were 150 autopsies, among which gall stones were found in only 3 cases, an incidence of 2 per cent.

The first patient was a male 56 years of age in whom two faceted stones, 1 and 7 centimeters in diameter, respectively, were found in the common duct. The second patient was a man 50 years of age, in whom the gall bladder was distended with black bile and the cystic duct closed by a soft elliptical non faceted stone, beside which some of the remains of much macerated ascaris was found. The rest of the worm had passed down into the common duct and had associated itself with a larger, soft non faceted stone 4 by 1½ centimeters in diameter. In the third patient a male, 38 years of age, reported by my colleague Dr. S. H. Shim a brownish black soft stone was found in the common duct. The stone which was broken in the process of removal contained the remains of an ascaris in its center.

The pathological department of the Government Keijo Medical College (8) reported 125 autopsies upon Koreans during the years 1914 to 1926 inclusive. In this series gall stones were found in 4 males whose respective ages were 26, 46, 46, and 68 years, and in one

TABLE I—DISTRIBUTION OF CASES OF CHOLELITHIASIS AT SEVERANCE HOSPITAL

Year	No cases gall stones	No of hospital patients	Ratio	No general operations	Ratio	No of laparotomies	Ratio
1916	1	1 125	1 : 115	511	1 : 511	43	1 : 43
1917	1	1 90	1 : 64	641	1 : 340	46	1 : 23
1918	1	1 650	1 : 650	509	1 : 509	31	1 : 34
1919	1	2 13	1 : 135	603	1 : 603	50	1 : 50
1920	0	1 070		670		53	
1921	1	1 833	1 : 183	831	3 : 11	72	1 : 72
1922	1	2 033	1 : 033	732	2 : 52	227	1 : 147
1923	1	1 971	1 : 971	820	1 : 800	129	1 : 129
1924	0	2 097		777		110	
1925	0	2 135		701		130	
1926	0	2 050		790		5	
Total	8	20 625	1 : 2 578 (0 036%)	7 203	1 : 975 (0 10%)	916	1 : 115 (0 846%)

The patient a woman aged 35 years was operated upon on June 24 1918. The right lobe of the liver was found to be enlarged to the level of the umbilicus and the gall bladder was bound to the duodenum by adhesion. The gall bladder was almost completely filled by two calculi one shaped like the gall bladder (8 by 4 centimeters) and the other a round stone (2 by 2 centimeters) which fitted into a facet in the large stone. A mass of smaller stones was found in the cystic common and hepatic ducts. Two stones about 1 centimeter in diameter were palpated in the liver substance and were removed through a dorsal incision into the liver. The common duct was closed and the gall bladder was drained. The patient made a good recovery and was dismissed from the hospital on August 31, 1918.

In another patient, there was a stone measuring 8 by 5 centimeters the largest we have ever seen in the common duct.

None of our patients with gall stones was under 30 years of age. However Rogers of Soonchun (Juntan), Korea recently reported the case of a Korean male aged 18 years who had several small stones in the gall bladder and one measuring 3 by 2 centimeters in the common duct. The stone in the common duct was brownish yellow in color and was so soft that it crumbled on being removed.

#### COMPARATIVE RACE INCIDENCE OF CHOLELITHIASIS

Considerable difficulty was encountered in making a comparison of the incidence of

TABLE II—SUMMARY OF THE CLINICAL CASES OF CHOLELITHIASIS IN KOREANS

Year	Hospital	No cases of gall stones	No hospital patients	Per cent	No general operations	Per cent	No of laparotomies	Per cent
1925	Yonsei (outside Seoul)	3	6 638	0 04	3 40	0 085	540	0 51
1916 to 1927	Severance	8	20 625	0 039	7 203	0 102	916	0 815
	Total	11	27 263	0 040	11 301	0 097	1 456	0 40

cholelithiasis among Koreans with that among people of other races. Inasmuch as China has been related so closely to Korea for many centuries, an effort was made to find out something concerning the incidence of gall stones in the former country. On account of the recent disturbances, reports were obtained from only 7 institutions but these hospitals represent widely separated sections and are among the largest in China.

Mole, of Moukden (Manchuria), found gall stones to be of rare occurrence, as during the year 1925 there was no case among 2 112 patients. In Moukden it has been difficult to obtain autopsies, only 25 having been performed in the past 15 years and among them no gall stones were found.

Van Gorder, of the Peking Union Medical College reported that in the year 1925 there were 2,883 Chinese in patients on all services. Among the 752 Chinese surgical in patients 5 cholecystectomies were performed, only one of which was for gall stones. While among 137 foreign in patients, there were 4 cholecystectomies, 3 of which were for gall stones. Previous to the year 1925 15 cholecystectomies were performed on Chinese patients, only 4 of which were for gall stones while among foreign patients, 17 cholecystectomies were performed, 11 of which were for gall stones. During the year 1925, the pathological department of the Peking Union Medical College recorded 65 autopsies upon Chinese patients and gall stones were found in 3 cases. In 8 autopsies upon foreigners no gall stones were found. The total number of autopsies upon Chinese previous to 1925 was 119, gall stones being found in 3 cases. The total number of autopsies upon foreigners previous to

TABLE V—AUTOPSY INCIDENCE OF CHOLELITHIASIS BASED ON RECORDS OF LAKESIDE HOSPITAL

White									
Male				Female			Total		
Age years	No of autopsies	No of gall stones	Per cent	No of autopsies	No of gall stones	Per cent	No of autopsies	No of gall stones	Per cent
0-10	255	0	0.00	183	0	0.00	438	0	0.00
11-20	72	1	1.39	42	0	0.00	114	1	0.88
21-30	185	6	3.19	141	9	6.38	326	15	4.56
31-40	185	7	2.45	187	15	8.02	372	22	4.66
41-50	294	21	7.14	141	22	15.60	435	43	9.89
51-60	212	22	9.90	78	11	14.10	290	33	11.03
61-70	133	21	15.79	60	15	25.00	193	36	18.65
71-80	45	8	17.77	12	4	33.33	57	12	21.05
81-90	4	0	0.00	5	2	40.00	9	2	22.22
91-100	0	0	0.00	0	0	0.00	0	0	0.00
Total	1,455	85	5.71	849	78	9.19	2,304	163	6.97

Negro									
Male				Female			Total		
Age years	No of autopsies	No of gall stones	Per cent	No of autopsies	No of gall stones	Per cent	No of autopsies	No of gall stones	Per cent
0-10	34	0	0.00	41	0	0.00	75	0	0.00
11-20	10	0	0.00	12	0	0.00	22	0	0.00
21-30	55	0	0.00	57	0	0.00	112	0	0.00
31-40	70	2	2.86	53	4	6.89	123	6	4.69
41-50	34	2	5.88	27	4	14.81	61	6	9.83
51-60	33	3	9.09	15	3	20.00	48	6	12.50
61-70	5	1	20.00	4	1	25.00	9	2	22.22
71-80	4	0	0.00	3	0	0.00	7	0	0.00
81-90	0	0	0.00	0	0	0.00	0	0	0.00
91-100	1	0	0.00	0	0	0.00	1	0	0.00
Total	246	8	3.25	217	12	5.53	463	20	4.32
C and total	1,701	93	5.36	1,066	90	8.44	2,767	113	6.54

associates that constipation is less frequent among the Koreans than among Westerners

3 *Diet* The Koreans are mainly vegetarian in their diet. "Rice is the great staple, millet and barley being frequently substituted for it in whole or in part, especially in North Korea. Peas and beans are often mixed with the rice and are otherwise important articles of food. Vegetables are eaten in some form at every meal. Fruits do not form an important part of the diet though there has been an increase in recent years. Meat is not much eaten by the poorer classes, but those who

can afford it eat a fair amount. Fish is eaten in great quantities, especially when salted or dried. All eat some eggs and little poultry. Milk, butter, and cheese are rarely used." More milk is now being used than was formerly the case. Van Buskirk (18) has summarized 79 diet lists, each reporting all the food consumed for one month, furnished by 42 different Koreans from various classes of people—students, office workers, merchants, apprentices in laboratory and drug room, farmers, laborers, and housewives. The average daily consumption for all, both men and

TABLE IV—COMPARATIVE RACE INCIDENCE OF CHOLELITHIASIS BASED ON CLINICAL STATISTICS

Reported by	Race	No cases gall stones	No hospital patients	Per cent	No general operations	Per cent	No of lapa- rotomies	Per cent
Lankenau Hosp (1921-1925)		452	21,380	2.114	12,003	3.735	8,436	7.34
Mayo Clinic (1925)	American	263	66,059	1.139	25,750	2.965	8,147	9.26
Lakeside Hosp (1925)		34	6,688	0.518	4,886	0.606	659	5.159
	Total	1,249	95,027	1.314	41,709	2.914	17,263	7.135
Valdes	Mexican	27	10,317	0.261	1,497	1.400	638	4.171
Ludlow	Korean	11	27,283	0.04	11,30	0.067	1,486	0.71
Wanless	Indian	4	961	0.133	4,640	0.086	686	0.533
Ludlow	Chinese	2	27,710	0.009	11,270	0.016	861	0.137
	Total	1,293	153,298	0.817	77,846	1.775	2,037	6.179

D is incomplete

Bloch	American	6			3,123	0.187		
Allyn	Negro	9	23,016	0.03				
Walton	British	109			76,310	0.335		
Scheidt	West Indian	11	61,176	0.07				
	Trinidad							
G and total	In patients General operations Laparotomies	1,313 1,708 1,293	145,410	0.555	152,450	1.180	20,977	6.179

female, 64 years of age. The total represented only 4 per cent of the cases. In this same institution, there were 96 autopsies on Japanese during the same period. Among these gall stones were found in 2 males, 44 and 53 years of age respectively, and in 2 females, 53 and 69 years of age, respectively, these 4 cases being 4.25 per cent of the total.

A comparison of the autopsy incidence of cholelithiasis among Koreans with that among people of other races was made. While on furlough, through the courtesy of Drs. Harry Goldblatt and A. R. Moritz I examined the records of 3,000 autopsies (February 2, 1898, to June 2, 1927) from the Pathological Department of Lakeside Hospital, Cleveland, Ohio. In this series, there were 2,800 complete autopsies, a summary of which is presented in Table V.

An analysis of Table V shows results similar to those reported by Mosher, the percent age of gall stones among the above 2,800 autopsies being 6.54 as compared with 6.94 among the 1,655 autopsies recorded by Mosher. Our American series confirms former observations namely:

1. The frequency of gall stones increases with the age of the patient examined and

their incidence is rare before the age of 40 years.

2. Gall stones are found more frequently in the white race than in the black race. Our series shows an incidence of 6.97 per cent among whites and 4.32 per cent among negroes. Mosher found 7.85 per cent among whites and 5.51 per cent among the negroes. Alden reports only two cases of gall stones among 696 autopsies which he performed on negroes in the Grady Hospital.

3. In our series gall stones are found more frequently among females than among males. The frequency of gall stones in 1,066 females was 8.44 per cent and among 1,734 males, 5.36 per cent. Mosher found the incidence of gall stones among 618 females to be 9.37 per cent and among 1,037 males, 5.94 per cent.

In support of the apparent infrequent occurrence of cholelithiasis among Koreans, a few factors deserve mention.

1. *Outdoor life.* As stated above, most of the Koreans are farmers and it is probable that at least 80 per cent of the people lead an outdoor life.

2. *Constipation.* While we cannot offer exact information as to the occurrence of constipation, it is the opinion of my Korean

the patient medical rather than surgical treatment. It is significant that 5 of our 8 patients had common duct stones.

3 *Laparotomies* Infections, osteomyelitis, empyema, fistulae in ano, hemorrhoids, tuberculosis, and injuries constitute a large part of the surgical work in Korea. Of late years, abdominal surgery has increased so that, at the present time, laparotomies amount to about 15 per cent of the total number of general operations, this percentage is about one half of that for ten American hospitals.

4 *Sex* In Western countries, gall stones are much more frequent in the female. In his series of 1,000 cases of cholelithiasis, McGuire (9) found that 71 per cent were in females. Deaver and Bortz report 327 females and 125 males in a series of 452 cases of calculous cholecystitis. In our series, there were equal numbers of males and females, but this can be explained, at least in part, by the fact that male patients predominate in Severance Hospital, in 1 year there being 1,280 males and 720 females among 2,000 patients.

5 *Age* In the series above mentioned, Deaver and Bortz record 187 patients below, and 265 above, the age of 40 years. As 80 per cent of our patients are under the age of 40 years, we do not expect to find many cases of gall stones.

6 *Multipara* Gall stones are more common among multiparae of other nationalities. If this is an important predisposing cause, then the Korean should be especially predisposed to gall stones, for statistics recently published by Van Buskirk and Mills (19) show 20,454 births among 5,000 Korean women. In the same series, the average number of children for each woman over 45 years of age was 5.7.

7 *Infection* Infection has been regarded by many authorities as one of the chief factors in the causation of gall stones. What a fertile soil Korea affords for infection both bacterial and parasitical! Infections of all kinds furnish the surgeon with a large percentage of his patients. Intestinal parasites, chiefly trichuris trichiura, ascaris ankylostomas, amœba and tenia are frequently present. Among 100 surgical patients trichuris was present 95 times, ascaris, 60 times, ankylostoma, 49

times, tœnia, 10 times, and trichastrogalus orientalis, 11 times. Eight patients had 4 varieties of parasites, 28 patients had 3 varieties, 4 had 2 varieties and 12 patients, 1 variety.

8 *Autopsies* The autopsies thus far performed are too few in number to warrant any positive statement as to the frequency of gall stones among Koreans, but these examinations reveal the absence of any racial peculiarities in the anatomy of the biliary passages.

Present statistics show that cholelithiasis is of less frequent occurrence among Koreans than among the Occidental races, but in view of the above mentioned factors, future investigations will doubtless reveal an increased incidence of the disease.

#### SUMMARY

1 The Korean, for centuries, regarded the gall bladder as related to the lung in function, but thought it to be an organ without an outlet.

2 Although the Korean recognized the existence of gall stones in the human body and valued them highly as a medicine, until modern times, he was ignorant of their exact source.

3 The clinical statistics of Severance Hospital, for the years 1916 to 1926 inclusive, show 8 cases of gall stones, an incidence of 0.039 per cent among 20,625 in patients, of 0.102 per cent among 7,805 general operations, and of 0.845 per cent among 946 laparotomies. Including all Korean statistics, there were 11 cases of gall stones, an incidence of 0.040 per cent among 27,283 in patients, of 0.097 per cent among 11,302 general operations, and of 0.740 per cent among 1,486 laparotomies. Among all races combined, the incidence of gall stones is as follows: among in patients, 0.535 per cent, among general operations, 1.120 per cent, and among laparotomies, 6.121 per cent.

4 In the Severance Union Medical College, in the years 1912 to 1926, inclusive, there were 150 autopsies. Gall stones were found in only 3 cases or 2 per cent. Including all Korean statistics, there were 275 autopsies, with gall stones in 8 cases or 2.91 per cent, as compared with 6.07 per cent for other races.



TABLE VI—COMPARATIVE RACE INCIDENCE OF CHOLELITHIASIS, BASED ON AUTOPSY REPORTS

Reported by	Race	% of autopsies	No. cases of gall stones	Per cent	Total percent
Schröder	German	1 750	141		12 26
Mitchell	Swiss	16 025	1 774		10 70
Mitchell	Austrian	19 974	1 557		7 80
Mentzer	American	627	173	20 09	0 0 23 cases
Opie		1 5	26	12 50	
Moher		1 028	80	7 8	
Ludlow		2 337	151	6 07	
Mitchell		2 473	48	3 33	
Rodman		2 050	37	2 80	
American	Total	6 515	451		6 97
Ludlow	British	10 8 1	235		4 00
Moher	Negro American	634	55	5 57	
Ludlow		463	10	4 37	
Mitchell		1 2	1	1 64	
Alden		696	2	0 29	
Negro	Total	2 915	59		3 05
Gov. Hosp (Ky.)	Japanese	96	4	4 16	
Myake		8 406	253	3 07	
Japanese	Total	8 502	257		3 05
Gov. Hosp (Ky.)	Korean	123	5	4	
Ludlow		150	3	2	
Korean	Total	273	8		2 97
Van Gorder	Chinese	135	6	3 85	
Stearns		16	0	0	
Mole		25	0	0	
Hofmann		20	0	0	
Chinese	Total	166	6		3 55
Clark	(West Indian) Negro Canal Zone	1 085	24		2 21
Scheult	West Indian Trinidad	7 557	5		0 07
Grand total		84,375	5 071		6 1

women, was as follows: protein, 82.1 grams, lipins, 20.3 grams, carbohydrates (by diff.), 52.3 grams—or a total food value of 2 608 calories. The amount of Vitamin A is doubtful.

The average amount of cooked rice and of rice mixtures was 1,725 grams a day for men and women, the women eating somewhat less than the men. This is about the equivalent of 575 grams of dry rice—a very great bulk. "Kimchi," the Korean pickle so commonly eaten, is also bulky, so that the total bulk of the diet is greater than can well be digested.

The protein utilization is only between 70 and 80 per cent. This is in accord with the findings of McKay, in India, and of the Japanese investigators. Animal protein furnished

on the average only about 22 grams a day. The amount of "fats" a day is only 0.3 grams—a very small amount in comparison with Western standards.

From observations among the natives of Java, China, Japan, and India, De Lange found that the cholesterol content of the blood and bile averaged 40 to 50 per cent less than that in Europeans. No observations have yet been made upon the Korean, but we hope that this will be done in the near future. Mentzer observes "that the low fat value of the food is concerned with the low lipid content of the blood and bile which is an inhibitory factor in the formation of the cholesterol 'common' stone. Gall stones have been produced experimentally in animals simply by excessive fat feeding. Disturbance of cholesterol metabolism of the body generally, or of the gall bladder wall locally, with the resultant increase in the cholesterol content of bile, is probably a primary factor in the formation of gall stones." If this theory proves to be correct, then it may account for the rarity of the cholesterol stone among Koreans as well as among the Japanese and other races classified as herbivorous. Only one cholesterol stone was found in our series of 8 cases.

There are certain considerations, on the other hand, which must be considered before any conclusions are drawn as to the infrequency of cholelithiasis among Koreans.

1. *Few hospitals and physicians.* The Korean population is approximately 19 000 000. According to the official returns at the end of 1925 the total number of hospitals in Korea was 107 including 27 Government institutions, 10 public hospitals and 70 private hospitals, of which 37 are Japanese, 11 Korean and 22 foreign mission and mine hospitals. The same returns put the number of regular physicians at 1 281. Many of the hospitals are small and most of them are in the larger centers of population. As 80 per cent of the population is farmers it is evident that few of the country people receive hospital care.

2. It is fair to assume from our experience with other surgical lesions, that only patients with severe cholelithiasis would consult a physician and that the physician would often give

DUODENAL AND GASTRIC ULCER, CHOLECYSTITIS, AND APPENDICITIS A CONSIDERATION OF THEIR PATHOLOGICAL RELATIONS<sup>1</sup>

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THE alimentary abdominal organs are co-ordinated in their functions. Disease in one part or member of the tract will disturb more or less, and in a variable manner, the functions of the others. This pathological process may involve other abdominal organs. The occurrence of hepatitis with cholecystitis and the etiological relation of gall bladder disease to pancreatitis are asserted frequently in the literature. Of alimentary, organic and inflammatory disease, appendicitis, cholecystitis, and peptic ulcer, gastric and duodenal, are the most frequent, and together entail the greatest hazard to life and health of all alimentary disease. The coincidence of cholecystitis and of peptic ulcer or of both with appendicitis repeatedly occurs in clinical laparotomy and autopsy records. The association has ceased to create surprise. The question as to the primary, the secondary, or the independent position of these associated diseases is not readily answered. That there is a sequential relation is asserted by surgeons of respected authority (Moynihan, Deaver, Trotter) whose experience encompasses the clinical recognition and the development of the diagnosis and surgery of these diseases. The occurrence of peptic ulcer and of cholecystitis in patients who have previously had an appendectomy also raises the question of pathological sequence. This question is generally as quickly lost in the current condemnation of the prevalence of appendectomy for chronic appendicitis. This is commonly assigned a clinical failure of 40 per cent. This failure is, in most instances asserted because the patient returns subsequently for continued or other abdominal symptoms. In the light of the definite coincidence of chronic disease of the appendix with other abdominal disease, the record of such clinical failure from unassociated appendectomy does not justify the conclusion that the failure is due solely to an error of diagnosis.

Characteristic morbidity liabilities are recognized for the succeeding decades of life. The

difference and the overlapping of the age incidence of associated diseases is not recorded. Heinrichsen complains of the lack of statistical material for the association of the abdominal triad. In a general summary of cases, the following analysis of the relations of the age incidences of these diseases seemed of interest in considering their pathological relations.

The material consists of a consecutive series of 4,742 complete gastro enterological studies during 4 years. The cases of appendicitis, duodenal and gastric ulcer, and of cholecystitis, clinically and roentgenologically diagnosed with many operative confirmations, have been reviewed to determine the incidence of association and their related age incidence. There are considered 345 cases of ulcer, 414 cases of cholecystitis with 194 cholecystectomies, and 542 instances of appendiceal disease with 110 unassociated appendectomies and 248 associated appendectomies. They have occurred during 4 years since the development of cholecystography. They were received from the university out patient gastro enterological service, from the free and private divisions of the hospital medical and surgical services, and from private office practice. They constitute a natural and representative selection of cases from an urban community. Reserving for another time a discussion of the entity of chronic appendicitis, of the roentgenological contributions to its diagnosis, and of the benefits of surgical interference, the assertion of these premises hardly needs to be made.

Cholecystography has contributed to the diagnosis of cholecystitis in these cases. It was done very nearly entirely by the intravenous method. The cholecystitis cases are those from the material of Graham, Cole, Copher and Moore, which received the associated study of serial gastro intestinal roentgenology.

The age of the cases at the time of the examination, and not the anamnesis data as to the age of initial symptoms, has been used

<sup>1</sup>Presented before the American Gastro-Enterological Association May 6 1929.

5 In explanation of the apparent infrequency of gall stones in the Korean, the following factors may be cited (1) outdoor life, (2) comparative freedom from constipation, and (3) a diet which is largely vegetarian and low in fats

6 In view of the following considerations it would be hazardous to claim that cholelithiasis is as rare in the Korean as our statistics would seem to indicate (1) the large number of people in Korea who, except for the most serious lesions, rarely consult a qualified physician or surgeon, of whom there are comparatively few, (2) the preference of the patient and often of the doctor for medical treatment, (3) the comparatively small number of laparotomies, (4) the predominance of male over female patients, (5) the age of the patients, 80 per cent being under the age of 40 years, (6) the large number of multiparæ, (7) the prevalence of infection, both bacterial and parasitical, (8) the small number of autopsies and the absence of racial peculiarities in the anatomy of the biliary structures

7 When Korea is supplied with more and better qualified physicians, future investigations will doubtless prove that cholelithiasis is more frequent among Koreans than is shown by our present statistics. The same will, no doubt, be true of the Chinese

## BIBLIOGRAPHY

- 1 ALDEN, H S Cholelithiasis and cholecystitis in the Negro South M J 1927 xx, 823-829
- 2 BIGGAR J D Pyeongyang Personal communication
- 3 DEAYNE J B and BORTZ E L Gall bladder a review of nine hundred and three cases. J Am M Ass 1927 lxxviii 619-623
- 4 DE LANGE Quoted by Emil Bloch. Surg Gynec & Obst 1926 xliii 465-475
- 5 DUNLAP R W Chefoo Personal communication
- 6 HOFMANN A Canton Personal communication
- 7 HUTCHESON A C Nanking Personal communication
- 8 KEIJO MEDICAL COLLEGE Personal communication
- 9 MCGETTIE S Opinions on various questions in gall bladder surgery based on 1 000 operations. Virginia M Month 1923 24, 1 683-692
- 10 MENTZER S H A clinical and pathological study of cholecystitis and cholelithiasis Surg Gynec & Obst 1926 xlii 782-793
- 11 MOLE R H Moukden Personal communication
- 12 MOSHER C D Bull Johns Hopkins Hosp 1901 xii 233-239
- 13 OLD T Canton Personal communication
- 14 RODMAN W L Influence of Race in Surgical Affections Keen's Surgery, Philadelphia & London 1908 vol iv p 1143
- 15 ROGERS M Mc Soonchun Personal communication
- 16 SHIM S H Ascaris and gall stones J Prac M Tokyo, 1923 February
- 17 STEARNS T Isinan Personal communication
- 18 VAN BUSKIRE J D The composition of typical Korean diets Japan Med World 1924 iv 127-131
- 19 VAN BUSKIRE J D and MILLS R G Korean child mortality Transactions of the Sixth Congress of the Far Eastern Association of Tropical Medicine Tokyo Japan 1925
- 20 VAN GORDER G Peking Personal communication

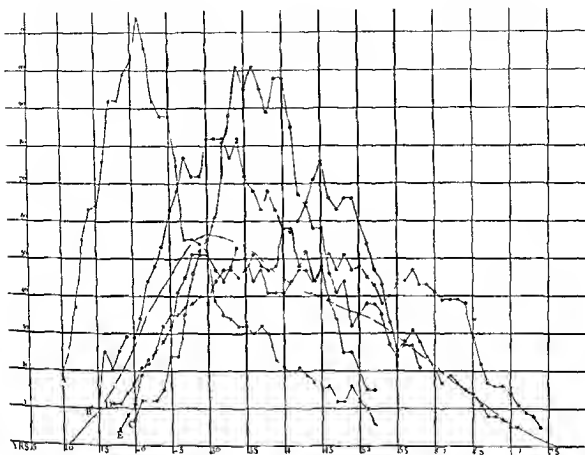


Chart 2: Demonstrates by age incidence curves plotted by the decennium incidence of equal numbers of cases for each group the relative segregation of these groups to different epochs. (See Chart 1 for curves of absolute incidence.) The appendectomies which preceded ulcers occur in the decade following unassociated appendectomies and their incidence curve *B* does not reach its height until after the curve for simple appendectomies *A* has passed into its terminal decline. The peak of the curve for preceding appendectomies *B* and of that for ulcer having previous

appendectomy *C* overlap and the latter curve persists for half a decade farther before dropping precipitately. It is followed half a decade later by a moderate peak in the curve *D* for the ulcers having an associated demonstrable pathological appendix. The curve for ulcers without associated appendiceal findings *E* shows little differentiation. The unbroken line characterizes the general incidence of all gastro intestinal cases and the variation in the character of the curves from this outline shows their departure from general age incidence.

appendectomy. Of all the cholecystitis cases operated upon, another 60 per cent show a pathological appendix at operation and 24 per cent show a normal appendix. Of all the gall bladders shown to be pathological either by operative confirmation or by cholecystogram, 14 per cent have had a previous appendectomy, and another 50 per cent show a roentgenologically pathological appendix, and 36 per cent give no evidences of appendiceal pathology.

The appendectomies which have been followed by a pathological gall bladder, con-

firmed operatively or by cholecystogram, were performed after the peak of the age curve for unassociated appendectomies and show approximately the same age occurrence as for those appendectomies which preceded ulcer. The average priority of appendectomy in this association was for the whole group, 97 years and was, for the two thirds 50 years. Thus, for the group, is a definitely longer interval than in the ulcer group.

Appendectomies which have been followed by ulcer have occurred chiefly in the years after the peak of the age curve for unasso-

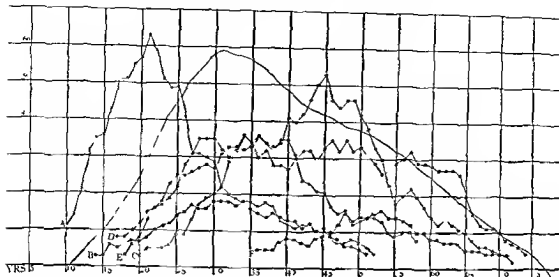


Chart 1: Demonstrates by age incidence curves plotted from decennium incidence of actual occurrence the relation of a group of unassociated appendectomies 4 and B of a group of appendectomies occurring previously in ulcer cases to several groups of gastric and duodenal ulcers group 1 C the ulcers that have been preceded by appendectomy group 2 D those ulcers that have an associated

pathological appendix group 3 E the ulcers that are accompanied by any signs of appendiceal disease group 4 F the triad of ulcer cholecystitis and appendiceal disease. The unbroken line shows the character (not the height) of the general incidence curve for all gastrointestinal cases and the variation in the character of the curves from this outline shows their departure from general age incidence.

The curves have been plotted from the decennium incidence determined yearly, and the end of that year (the fifth of the decennium) has been used as the mid point of the decennium.

The cases considered in this paper, in which appendectomy had been performed, and in which ulcer or cholecystitis followed were examined in most instances only at the time of the subsequent disease. They are a group naturally selected by the subsequent development of ulcer or cholecystitis. They are not representative of the group of 40 per cent of failures for appendectomy in chronic appendicitis. The anamnesis shows many to have been valid cases of acute or recurrent appendicitis.

The unassociated appendectomy cases received both clinical and roentgenological studies. Their age incidence has been determined to coincide with that of acute and subacute cases which were operated upon after clinical examination alone. Operative confirmation in these cases which had the combined studies has justified reliance upon the help of the X ray signs used.

The ulcer cases were fully studied and the final diagnosis was made upon the combined clinical roentgenological, and laboratory evidence. Deformity of the duodenal bulb and unequivocal and characteristic change in the gastric contour were demonstrated in most of the cases.

Instances in which there was a coincidence of ulcer cholecystitis and appendiceal disease occurred in 4.9 per cent for all ulcers, 4.1 per cent for all cholecystitides. In all cases of associated ulcer and cholecystitis in which operation was done, the appendix gave positive evidence of present or past inflammatory disease. This association of the three localized inflammatory processes occurs late in life after the period of greatest frequency for ulcer and cholecystitis unassociated with each other.

Of the peptic ulcer group 18 per cent have had a previous appendectomy, another 40 per cent show definite X ray evidence of appendiceal pathology and the remaining 42 per cent yield no clinical or X ray signs of appendiceal pathology which does not, however, exclude it conclusively. Of cholecystitis cases coming to operation, 16 per cent have had a previous

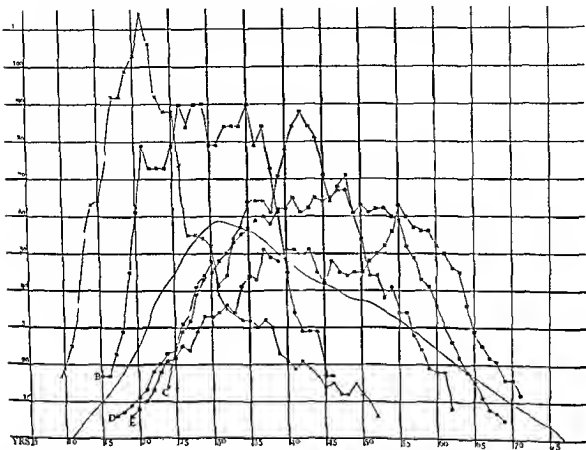


Chart 4. Demonstrates by age incidence curves plotted from the decennium incidence of equal numbers of cases for each group the relative segregation of these groups to different epochs. (See Chart 3 for curves of absolute incidence.) The appendectomies which preceded cholecystitis occur in the decade following unassociated appendectomies and their incidence curve *B* does not reach its height until after the curve for unassociated appendectomies *A* has passed into its terminal decline. The prolonged peak of the curve for preceding appendectomies *B* precedes by half a decade the curve for cholecystitis having previous appen-

dectomy *C*. The curve for cholecystitis having an associated demonstrable pathological appendix *D*, is a wide curve through the two middle decades (36-55) of life and reaches its height half a decade after the cases having preceded appendectomy *C*. The curve for cholecystitis with out associated appendiceal findings *E* is a broad low curve having a terminal peak more than half a decade later just before its precipitate decline. The unbroken line characterizes the general incidence of all gastro intestinal cases, and the variation in the character of the curves from this out line shows their departure from general age incidence.

both ulcer and cholecystitis occurring late in life, in which there is demonstrable change in the appendix, and in many of which there is both an associated history and roentgenological evidence of previous subacute or acute attacks prompts an affirmative answer. Certainly it may be said that those appendectomies which occur late in the usual period of unassociated appendectomies, or rather those which, as seen on the charts, form the descent of the age incidence curve, are more likely to be followed by ulcer and cholecystitis. It is further noted that the occurrence of roentgeno-

logical signs of appendiceal disease in the presence of normal cholecystography diminishes reciprocally to the progressive increase with age of the occurrence of associated cholecystitis and appendiceal disease.

To attach greater significance to or to emphasize chronic disease of the appendix may be deprecated in the presence of the current critical discussion of appendectomy. This view of the relations of the appendix cannot be used to increase the indication for appendectomy. A conception, such as is suggested, of the large influence that appendiceal infec-

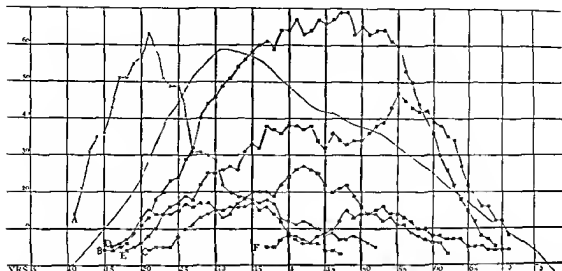


Chart 3. Demonstrates by age incidence curves plotted from the decennium incidence of actual occurrence the relation of a group of unassociated appendectomies *A* and *B* of a group of appendectomies occurring previously in cholecystitis cases to several groups of cholecystitis: group *C*, the cholecystitis cases that have been preceded by appendectomy; group *D*, those cholecystitis cases

that have an associated pathological appendix; group *E*, the cholecystitis cases unaccompanied by any findings of appendiceal disease; group *F*, the triad of cholecystitis, ulcer and appendiceal disease. The unbroken line characterizes the general incidence of all gastro-intestinal cases and the variation in the character of the curves from this outline shows their departure from general incidence.

ciated appendectomies and have averaged 7.6 years prior to my demonstration of ulcer and for two thirds of these appendectomies, the interval was 3.7 years.

There are in the curve of the residual group of those ulcer cases giving no appendiceal findings moderate peaks corresponding to those of the appendectomized (operated) group and pathological (diagnosed) group.

These associations do not necessarily signify anything other than coincidental disease. They do allow theoretical explanation on a basis of pathological processes.

#### DISCUSSION

The association of peptic ulcer and cholecystitis has been shown to have only a small percentage for the respective diseases. It has always occurred with associated appendiceal pathology. The frequent association of appendiceal pathology with each ulcer and cholecystitis, the differing total incidence of these two diseases in men and in women, and their associated occurrence only late in their separate age incidences tends to minimize their direct reciprocal etiological relationship.

The occurrence of 18 per cent of previous

appendectomies in ulcer cases and of 14 per cent in cholecystitis entertains four interpretations: that there was originally an error in diagnosis; that the diagnosis was incomplete; that the subsequent disease was acquired independently, or as a sequel.

The charts have placed the group of appendectomized cases, naturally selected by having had subsequent upper abdominal disease into the terminal portion of the incidence curve for simple appendectomy. Their curve of incidence lies between the curve for simple appendectomy and those for ulcer and cholecystitis. Do these cases represent originally mistaken diagnoses? Among them are by the anamnesis unmistakable cases of acute appendicitis and many valuable chronic cases. A portion may have been complete errors. Do any of the valid cases represent at the time of the appendectomy an incomplete diagnosis? This is unanswerable. It is possible. Have these cases carried an appendiceal affection through and beyond the usual period of appendicitis, delaying or failing of operation until an abdominal infection is established which later localizes and manifests itself as ulcer or cholecystitis? The large percentage of cases of

# CLINICAL SURGERY

FROM THE CLINIC OF LORD MOUNTAIN

## LEFT PARTIAL COLECTOMY

DIGBY CHAMBERLAIN CHM FRCS LEEDS ENGLAND

Hon Assistant Surgeon General Infirmary Leeds

GROWTHS in the left half of the large intestine may be resected, either after a preliminary caecostomy if there has been any obstruction or at once if there has not been an acute attack. A colectomy with an anastomosis between the two ends should never be done when the colon proximal to the growth shows any evidence of obstruction, and even in the quiet cases it is an additional safeguard to drain the caecum. It must be remembered that the bowel contents on the left side are solid and that any movement subjects the suture line to a considerably greater injury than on the right side of the colon, where it is only the liquid small intestine contents which pass through the opening.

When we are considering the amount of bowel which should be removed, we must bear in mind the local spread of the growth, the blood supply, and the lymphatic drainage. Carcinoma of the colon is a local disease in the large number of cases it remains confined to the region of the primary growth and the neighboring glands almost always, and even in cases coming to postmortem examination only 14 per cent show any visceral deposits. The growth may appear to be small and abruptly limited but in a case of this kind carcinoma cells have been demonstrated which have permeated the bowel wall 6 inches above the lesion.

The blood supply of the left half of the colon comes partly from the middle colic artery and from the branches of the inferior mesenteric artery. These vessels divide and the branches anastomose one with the other a particularly free junction taking place between the middle colic artery and the ascending branch of the left colic artery (the anastomosis magna of Riouan). There is also a free anastomosis between branches of the left colic and the sigmoid arteries forming an artery which has been called the marginal artery, which lies close up to the bowel wall and reaches from the splenic flexure to the lowest part of the sigmoid colon. The importance of this marginal

artery has been demonstrated by Archibald who has shown that the blood it receives from the middle colic artery is sufficient to maintain the vitality of the descending and sigmoid colon after the inferior mesenteric artery has been ligated at its commencement. The superior hæmorrhoidal artery does not divide into branches which anastomose with the sigmoid arteries and there is, therefore, no marginal artery below the lowest sigmoid vessel. Ligation of the superior hæmorrhoidal artery and the lowest sigmoid artery will result in gangrene of that part of the bowel supplied by those vessels. Ligation of the inferior mesenteric trunk above the lowest sigmoid branch will allow that vessel, supplied by the marginal artery, to convey blood into the superior hæmorrhoidal artery. This junction between the superior hæmorrhoidal artery and the lowest sigmoid artery Sudeck calls the "critical point."

The lymphatic vessels correspond closely with the arteries. Glands lie along the margin of the intestine between it and the marginal artery, and also along the main trunks of the arteries, particularly at the points of bifurcation and of origin. In addition to this, lymphatic channels run from the splenic flexure and the descending colon toward the glands at the hilum of the spleen.

It may be laid down that for growths in the region of the splenic flexure about one third of the transverse colon and one half or rather more of the descending colon should be removed. For growths in the descending colon one third of the transverse colon, the descending colon and a small portion of the sigmoid flexure should be removed for growths in the sigmoid flexure, the whole of that part of the colon together with the lower end of the descending colon should be excised.

### PRE OPERATIVE TREATMENT

The patient is kept in hospital for some days before the operation in order that his general health may be improved as far as possible. Sepsis



TABLE I—SUMMARY OF 4,742 GASTRO INTESTINAL CASES STUDIED DURING FOUR YEARS

	Male	Female	Total
Ulcer cholecystitis and appendiceal disease coincidental	11	6	17
Gastric	3		3
Gastric and duodenal	1	1	2
Duodenal	7	5	12
Ulcer and cholecystitis			
Without appendiceal findings	3	2	5
With previous appendectomy	5	2	7
Ulcer with previous cholecystectomy and appendectomy	4	2	6
Number of ulcers			
With previous appendectomy	40	30	70
Gastric	3	5	8
Duodenal	37	25	62
With associated pathological appendix	100	39	139
Gastric	14	9	22
Duodenal	87	30	117
Without appendiceal findings	102	34	136
Gastric	17	5	22
Duodenal	85	29	114
Totals	242	103	345
Gastric	33	19	52
Duodenal	209	84	293
Number of cases of cholecystitis			
With previous appendectomy			
Having cholecystectomy	8	23	
Without operation	9	0	60
With associated pathological appendix			
At cholecystectomy	35	20	
Without operation	3	58	203
Without appendiceal findings			
At cholecystectomy	12	36	
Without operation	37	64	149
Total	133	281	414
Unassociated appendiceal disease			
Having operation	32	78	110
*Unoperated upon	38	50	88

(Ulcer and cholecystitis absent by clinical and roentgenological examination)

tion plays in the development of other inflammatory abdominal disease, especially of cholecystitis and ulcer, can only force upon the clinician the necessity for all direct and eliminative diagnostic methods. Appendectomy, even when done upon a complete and accurate diagnosis, does not extirpate all the inflammatory process or remove the hazard of upper abdominal disease. Pathology is inherently progressive. The body defense mechanism may limit and stop it. The shift of ascendancy is a function of time in the self limited dis-

cases. In others, the progression is not so orderly and often surgical interference at the focus of the process is necessary. Extirpation of this point, as in appendicitis, does not remove all of its extensions. The control of these is not immediate, and the sequelæ of appendicitis may occur more or less remotely after appendectomy. Mistaken and incomplete diagnoses are not the necessary explanations for the so called clinical failures, even if often applicable. It should not be inferred that the appendix is thought to be the sole source of infection for peptic ulcer and cholecystitis. It is believed that the position of the appendix as a frequent initial site for abdominal infection is in danger of being obscured by the reaction from hasty surgery of the appendix. Unfortunately, the usual technical ease of appendiceal surgery is disproportionate to the difficulties of adequate and certain diagnosis of the acute as well as the chronic disease.

#### SUMMARY

The statistical relation of ulcer, cholecystitis and appendiceal disease in a large series of studies of gastro intestinal cases has been determined, and the age incidence of their occurrence has been plotted to show their further relations. Appendiceal disease has been associated in the majority of ulcer and cholecystitis cases. Appendectomies have occurred prior to the finding of ulcer and cholecystitis in a significant percentage of the cases, and, by the anamnesis, have usually been done on a valid diagnosis. These appendectomies are shown to have occurred chiefly at a period later than is usual for unassociated appendicitis. Ulcer, cholecystitis, and appendiceal disease are, all three, concomitant in only a small percentage of cases. The relation of these facts as indicating an infectious etiological connection of the lesions in these sites is discussed. The need for both direct and eliminative findings in reaching a diagnosis of chronic appendicitis is emphasized.

#### REFERENCES

1. DEEVER: Appendicitis. J. Am. M. Ass. 1928 xc 169
2. HEINRICHSEN: Beitr. z. Klin. Chir. 1927 cxi 149-164
3. MONTHEAN: Duodenal Ulcer. p. 184
4. TROTTER: Brit. M. J. 1927 ii 1063

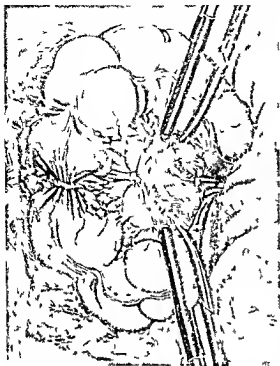


Fig. 3 Mesocolon divided and clamps applied. The colon is ready to be divided.

to make an anastomosis. The inner edge of the peritoneum is stripped inward toward the middle line, a little gentle pressure with a gauze swab being quite sufficient to effect the separation. This separation carries the colon with it until it is possible to pass underneath the colon up to the middle line. The ureter must be seen and preserved from injury as it is very liable to remain adherent to the peritoneum and to be stripped up with it. Rough handling may injure the spermatic, ovarian or other retroperitoneal veins and cause a certain amount of troublesome bleeding. When the left part of the transverse colon is removed, it is better to leave the omentum, and to do this it is necessary to free it. If the omentum is pulled upward and the transverse colon held downward as far as possible the two will be put on the stretch and the peritoneum covering the colon can be freed from the omentum with a few touches of the knife. The separation can be continued with gauze stripping helped if necessary by the knife from time to time until the transverse colon and mesocolon are quite free.

When this has been done it will be found that the transverse colon, the descending colon, and the sigmoid flexure have been mobilized the fetal condition has been reproduced and they are at

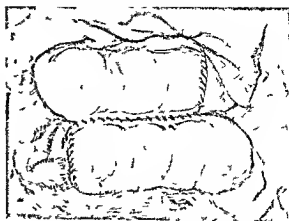


Fig. 4 Lateral anastomosis completed

tached to a mesentery which is springing from the neighborhood of the left side of the vertebral column. Further when this mesentery is held up to the light the contained blood vessels are perfectly obvious even in those cases in which there is a good deal of extraperitoneal fatty tissue. These vessels are recognized and two ligatures are passed round the left colic artery by means of an aneurism needle, tied, and the vessel is divided between them. Should there be glands on the inferior mesenteric artery above the origin of the left colic they are to be dissected out and the fatty tissue which contains them stripped down until it lies below the point of ligature of that vessel. From this point incisions are carried through the peritoneum to the points at which it has been decided to divide the gut. As these incisions are being made, it will be necessary to divide and ligate the anastomotic branch of the middle colic artery above and the marginal artery below. The piece of colon which is to be removed is now lying with a triangular piece of mesentery attached to it. It is divided by means of a cautery between double clamps at each extremity and removed. The clamps which are applied to that part of the intestine which is to be left behind are crushing clamps, with the grooves parallel to the length of the blade, those which are applied to the part which is to be removed are ordinary rubber covered gastro enterostomy clamps which are closed as tightly as possible. The two ends of the colon are closed by a Pagenstecher thread stitch put in as follows. The clamp is held by an assistant and rotated first one way and then the other so that the two sides are alternately made accessible. Starting at the mesenteric border this stitch is carried over the clamp from side to side until the opposite end is reached. The stitches

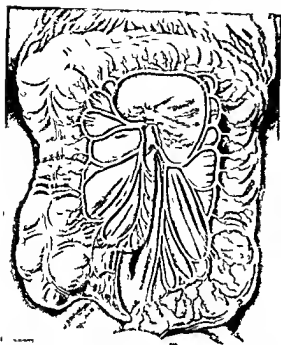


Fig 1 The blood supply of the colon

is dealt with if it is present and fluids are administered by means of a 5 per cent solution of glucose. If the condition is bad a transfusion of blood is given. The diagnosis is confirmed by means of a barium enema or a sigmoidoscope examination if the growth is low down. A general survey is made to locate any malignant deposits which would render the case inoperable. It is better not to give aperients as they may precipitate an acute obstruction, but to rely on rectal lavage to empty the colon as far as possible.

#### THE OPERATION

Although it may be an advantage to place the patient in the Trendelenburg position when the growth is low down in the sigmoid colon in most cases this is unnecessary and easy access may be had with the table flat. The anæsthetic of choice is nitrous oxide gas and oxygen reinforced from time to time with a little ether and a preliminary injection of morphia, scopolamine and atropine. The abdominal wall is prepared by cleaning it with ether soap followed by a solution of bichloride of mercury in spirit and then Harrington's solution. The sheets are put in position and the abdomen is opened by an incision over the left rectus muscle that muscle being displaced outward. Before the peritoneum is incised the skin



Fig Mobilization of the colon

edges are protected by tatra cloths which are clamped to the edges of the wound. The incision should be about 8 inches in length and its site can be varied according to whether the growth is in the upper or lower part of the colon. The peritoneum is opened and after the growth has been found and examined the rest of the abdomen is searched for secondary deposits. The glands, the liver, the hilum of the spleen, the bottom of the pelvis and the ovaries in the female are examined in turn and if this examination is satisfactory the operation is proceeded with. It is not uncommon to find the omentum adherent to the growth and it may be necessary to divide the adherent part between double ligatures at this stage. The small intestine is then packed out of sight with hot mackintosh swabs and everything is covered but the part actually being dealt with.

The left edge of the wound is retracted by an assistant and the bowel is pulled over to the right as far as possible so as to put the peritoneum on its outer side on the stretch. The peritoneum is then incised about 1 inch outside the colon, the incision extending along the whole length of the colon to be removed and extending through the costocolic ligament in those cases in which the splenic flexure is to be removed or in which it will be necessary to displace it downward in order



Fig 3 Mesocolon divided and clamps applied. The colon is ready to be divided.



Fig 4 Lateral anastomosis completed

to make an anastomosis. The inner edge of the peritoneum is stripped inward toward the middle line, a little gentle pressure with a gauze swab being quite sufficient to effect the separation. This separation carries the colon with it until it is possible to pass underneath the colon up to the middle line. The ureter must be seen and preserved from injury as it is very liable to remain adherent to the peritoneum and to be stripped up with it. Rough handling may injure the spermatic, ovarian or other retroperitoneal veins and cause a certain amount of troublesome bleeding. When the left part of the transverse colon is removed it is better to leave the omentum and to do this it is necessary to free it. If the omentum is pulled upward and the transverse colon held downward as far as possible the two will be put on the stretch and the peritoneum covering the colon can be freed from the omentum with a few touches of the knife. The separation can be continued with gauze stripping helped if necessary by the knife from time to time until the transverse colon and mesocolon are quite free.

When this has been done it will be found that the transverse colon, the descending colon and the sigmoid flexure have been mobilized the fetal condition has been reproduced and they are at

tached to a mesentery which is springing from the neighborhood of the left side of the vertebral column. Further when this mesentery is held up to the light the contained blood vessels are perfectly obvious even in those cases in which there is a good deal of extraperitoneal fatty tissue. These vessels are recognized and two ligatures are passed round the left colic artery by means of an aneurism needle tied, and the vessel is divided between them. Should there be glands on the inferior mesenteric artery above the origin of the left colic they are to be dissected out and the fatty tissue which contains them stripped down until it lies below the point of ligature of that vessel. From this point incisions are carried through the peritoneum to the points at which it has been decided to divide the gut. As these incisions are being made it will be necessary to divide and ligate the anastomotic branch of the middle colic artery above and the marginal artery below. The piece of colon which is to be removed is now lying with a triangular piece of mesentery attached to it. It is divided by means of a cautery between double clamps at each extremity and removed. The clamps which are applied to that part of the intestine which is to be left behind are crushing clamps with the grooves parallel to the length of the blade, those which are applied to the part which is to be removed are ordinary rubber covered gastro-enterostomy clamps which are closed as tightly as possible. The two ends of the colon are closed by a Pagenstecher thread stitch put in as follows. The clamp is held by an assistant and rotated first one way and then the other so that the two sides are alternately made accessible. Starting at the mesenteric border this stitch is carried over the clamp from side to side until the opposite end is reached. The stitches

are placed parallel to the clamp and pick up the gut about  $\frac{1}{4}$  inch from it. The stitch is held tightly at both ends, while an assistant frees and removes the clamp when the thread is at once drawn tight. The stitch is then made to return to its starting point, the first line of sutures invaginated as it goes along, and the two ends tied together.

The two closed ends of the colon are then made to lie side by side, the sigmoid lying below the transverse colon. Rubber covered clamps are applied preparatory to a lateral anastomosis, in such a way that they will permit the opening to be at least  $2\frac{1}{2}$  inches in length and situated along the muscular bands. Care is taken to see that the ends are not twisted and that the small intestine is well packed out of the way in the right side of the abdomen. Everything is protected by mackintosh swabs and the anastomosis may be proceeded with. The two pieces of colon are stitched together, along the length of what is going to be the anastomosis by a thread stitch. Incisions are made into both of them parallel, and at least  $2\frac{1}{2}$  inches long, as I have already stated. The mucosa is cleaned with swabs and as a final precaution a piece of gauze soaked in ether is pressed on to it for a minute or two. An inner stitch of chromicized catgut is inserted. It goes through all the coats of the gut wall, joins the adjacent sides of the two openings, then is made to pick up the two outer sides of the openings, and finally arrives at its starting point where it is tied off. The clamps are removed and at this stage all the swabs are changed for clean ones and the surgeon and his assistant change their gloves. The outer thread stitch is completed by taking it along the anterior surface of the anastomosis back to its starting point where it is tied. The suture line may be reinforced, particularly at the two corners, by a few catgut sutures.

It has been found that discomfort after removal of the colon has been due to a blowing out of the two blind ends. To overcome this the anastomosis should be done as close to the ends as possible so that there shall be left as little blind end as possible. Further this blind end may be buried in the wall of the colon. The blind end of the sigmoid lies in contact with the transverse colon proximal to the anastomosis. The two may be stitched together and the sigmoid buried in the wall of the transverse colon so that even the stitch used to close its end is covered up. Care should be taken to see that the main lumen of the colon is neither pressed on nor kinked. The blind end of the transverse colon which is lying in contact with the lower sigmoid is dealt with in the same way.

The cut edges of the mesentery are approximated and joined together by interrupted catgut sutures, and it will be found that when the colon is returned to the abdomen all the raw surfaces have been covered up. Any deficient place in the peritoneal coat should be covered with omentum and, further, the omentum should be wrapped round the suture line and fixed if necessary by a stitch or two, to prevent adhesions from forming.

The abdomen is closed in layers, a continuous catgut suture being used for the peritoneum and interrupted catgut sutures for the anterior layer of the rectus sheath. Five or six silkworm gut sutures are inserted so as to include the skin, subcutaneous fat, and the anterior layer of the rectus sheath, and a small piece of fine rubber tubing is threaded over them before they are tied so as to prevent them from cutting into the skin. Finally the skin edges are approximated with Michel's clips. The wound is covered with a sterile dressing, glued to the skin to prevent it from slipping and the patient is returned to bed.

#### POSTOPERATIVE TREATMENT

The patient is propped up into Fowler's position as soon as he recovers from the anæsthetic and the general condition permits of it. Nothing is to be given by the rectum. If the condition is poor and fluids are urgently needed they must be given either subcutaneously or intravenously, otherwise he may start to take small drinks of water on the morning following the operation and they may be increased in amount as time goes on. No solid food is to be given until the seventh day when a little milk pudding can be taken.

No attempt should be made to force the bowels to open during the first 7 days after that time liquid paraffin should be given night and morning and will produce the desired result. If there is a cæcostomy opening there will be no discomfort, but if not there may be a good deal of complaint of distention and flatulence. It is better not to take active measures to get rid of this for the patient will pass flatus sooner or later.

The patient may be allowed out of bed about the fourteenth day and is usually ready to leave the hospital a week later.

Although not so common as after resections of the right side of the colon diarrhoea is not infrequently a very distressing after effect. In the resistant cases it will react only to morphia but in the majority of cases it will subside if the patient takes bulky meals, drinks only between meals and takes a bismuth mixture. It is to be expected to cause some upset for about 6 months but after that time should disappear completely.

FROM THE CHIRURGISCHE UNIVERSITÄTSKLINIK OF HALLE

## THE TECHNIQUE OF THE VOELCKER EXTRAPERITONEALIZATION OF THE URINARY BLADDER

WITH ILLUSTRATIVE CASES

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THE concealed position of the bladder in the pelvis, surrounded as it is by a bony ring and partly covered with other organs, creates a need for a special operation of approach in cases in which a wide exposure of the bladder is necessary. This is true particularly when the bladder is empty. For ordinary operations, such as the removal of stones and foreign bodies for suprapubic prostatectomy, and even for resection of the anterior bladder wall the usual suprapubic extraperitoneal bladder exposure offers the simplest and best method of approach. One of the main difficulties that accompany this procedure, besides the obstacle offered by the bony symphysis, is the reflection of the peritoneum over the bladder. If the bladder is empty, an extraperitoneal approach is impossible. Fortunately, however, when the organ is filled with either fluid or air it is possible, due to the loose connection between the peritoneum and anterior bladder wall, to expose, in large part, the anterior wall of the bladder by bluntly pushing the peritoneum upward.

However, in those operations in which greater exposure and accessibility are necessary, as in the case of infiltrating tumors of the bladder, vertex or in the lateral and posterior bladder walls with possible adhesions to neighboring organs, and when dealing with certain diverticula of the bladder, this simple extraperitoneal bladder exposure will not suffice. When resection of malignant tumors, or of diverticula lying in the postero-lateral and posterior walls, or total extirpation of the bladder is considered, the maximum exposure is necessary. In attempting to obtain this desired exposure and mobilization of the bladder through the suprapubic incision, one encounters the peritoneum which, although fastened but very loosely to the anterior and posterior walls, is firmly attached to the bladder vertex over an area about the size of a silver dollar coin, which attachment prevents the complete freeing of the bladder. This problem is approached in different ways by the various methods in use.

The method much in vogue in America is the transperitoneal approach of Rydygier (2 and 12).

With the patient in the steep Trendelenburg position, the peritoneal cavity is opened immediately by intention. A longitudinal incision then cuts through the bladder wall with the adherent peritoneum, thereby opening widely the posterior wall of the bladder. In this manner the posterior bladder wall is made movable and approachable. However, in spite of careful packing off and in spite of the well known resistive ability of the peritoneum, this method of opening the usually infected bladder transperitoneally nevertheless harbors a definite danger of peritonitis. Also the danger of implantation metastases in cases of neoplasm is to be considered. By means of other methods, however, these dangers can be avoided.

The method of Lichtenberg (9) seeks to free the peritoneal fold from its attachment to the bladder vertex by means of blunt dissection without opening the peritoneal sac, however. In cutting the operator directs the scalpel more toward the bladder wall than toward the peritoneum. Only exceptionally, however, does one succeed in thus bluntly stripping off the peritoneal cap from the bladder. In the region of the vertex, the peritoneum is apt to be found so adherent that it will be torn in the attempt to separate it from the bladder. Moreover, it is probable that with this method small holes may be torn into the peritoneum without their being noted, thus harboring a hidden danger.

Based on the above deliberations, the Voelcker method of extraperitonealization of the bladder originated a procedure that combines the advantages of the extraperitoneal, with the excellent exposure offered by the transperitoneal, operation. The essence of the operation consists in the primary excision of the adherent section of peritoneal fold from the bladder vertex and in the careful and exact suturing of the peritoneal slit. The lateral and posterior walls of the bladder are then bluntly mobilized, this being easily accomplished, since in these areas the bladder is joined with the peritoneum by very loose cellular tissue. With this modification the suprapubic bladder exposure makes possible any extensive resection of the bladder which may be necessary.

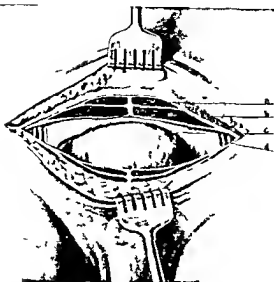


Fig 1 The Bardenheuer transverse incision. *a* Musculus pyramidalis *b* musculus abdominis *c* peritoneal fold *d* inferior epigastric vessels<sup>1</sup>

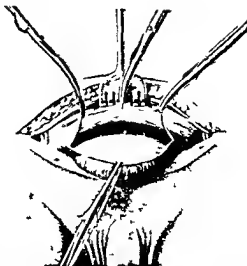


Fig 2 Extraperitonealization of the bladder (Voelcker). First step. The peritoneum is opened at the bladder vertex and the adherent peritoneal cap is excised.

The procedure as described below seems not to have found its way into the American literature. The technique of this extraperitonealization of the bladder as practiced by Voelcker is as follows:

The preparation of the bladder is carried out as for the usual suprapubic operation. Lumbar or general anesthesia as indicated is used. In order completely to utilize the advantages of this method in major bladder operations such as resection, diverticulectomy, and total extirpation the Bardenheuer transverse incision through skin and musculature is preferable to the vertical incision. The transverse incision can be carried more to the right or left of the middle line depending upon indication. The patient is always placed in the steep Trendelenburg position. After division of skin, muscle and fascia transversalis in the transverse direction one finds the peritoneal fold (Fig 1) on the anterior bladder surface and attempts first of all to displace the peritoneum upward by blunt dissection. If these efforts have been successful the peritoneum is then transversely incised at its most posterior adherent point and the incision then carried laterally in both directions a distance equal to the extent of its transverse adherence to the bladder vertex (Fig 2). The apex of the bladder is then drawn forward and displaced downward so as to emphasize the

cleavage line between the posterior bladder wall and peritoneum. At this cleavage line the peritoneum is again incised at the point where it is no longer adherent to the bladder and this incision is sufficiently lengthened transversely in both directions so as to meet the lateral ends of the anterior peritoneal incision. The excised elliptiform flap remains hanging on the bladder and thereafter requires no further attention. The margins of the peritoneum are then grasped with clamps; the peritoneum is further separated by blunt dissection from the posterior wall of the bladder and the opening in the peritoneum is then exactly closed with continuous or interrupted sutures (Fig 3). This extraperitonealization is in itself a relatively small operative procedure and especially with the proper Trendelenburg position is easily carried out. During the further course of the operation the peritoneal sutures are protected by compresses.

It is striking how much the complete exposure of the bladder will be facilitated through this procedure for if the bladder is now pulled well forward the entire posterior and lateral walls can be bluntly dissected free and like other organs for example the gall bladder prepared as if hanging from a pedicle (Fig 4). This method of suprapubic exposure with extraperitonealization makes every part of the bladder easily accessible for all major operative procedures and vouchsafes also an excellent approach to the juxta-vesical

<sup>1</sup>The illustrations in this article are from Vol. by Voelcker, J. Boettgerhaus in *Handbuch der Chirurgie*, Berlin, Springer, 1910.

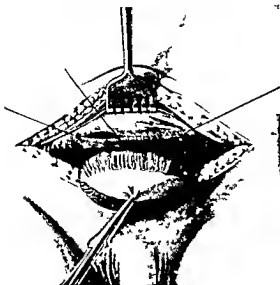


Fig 3 Extraperitonealization of the bladder (Voelcker)  
Second step. The extraperitonealized bladder is drawn forward and the defect in the peritoneum is closed with continuous suture

ureteral segments in case of ureterolithotomy for incarcerated stone in this region. The usefulness of this method of approach in this condition has been confirmed by the experience of Rubritius, Blum, and others.

The principal advantage of the Voelcker method lies in the fact that the superior accessibility gained is not purchased at the price of a greater risk as in the case of the transperitoneal approach for the peritoneal cavity is closed off before the bladder is actually opened. The change in the normal anatomical relationship between the peritoneum and the bladder created by this procedure is only temporary of which fact one can readily be convinced by observing such cases which may happen to go through another laparotomy for other conditions a short time thereafter in which it is found that the normal relationship has re-established itself.

To illustrate the usefulness of this method, some case reports of patients operated upon in this clinic during the past 2 years for bladder conditions are given below.

#### CASE 1. Diagnosis malignant papilloma

L. P. a man aged 55 years complained for the past 2 months of painful frequent micturition and hematuria and showed at cystoscopic examination an ulcerating tumor of the left bladder wall.

Operation. A Bardenheuer transverse abdominal incision carried more to the left of the median line than to the right was made. The bladder was then extraperitonealized according to the method described above. Following mobi-

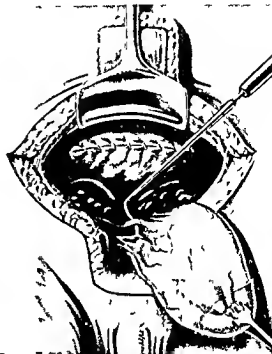


Fig 4 Total extirpation of the bladder with temporary resection of the symphysis. Following excision of the adherent peritoneal cap at the bladder vertex the posterior and lateral walls are then bluntly mobilized so that the bladder remains fixed only at its neck as if hanging from a pedicle.

lization of the bladder an infiltration of the left bladder wall was palpable whereas previous to the extraperitonealization it could not be felt. An opening in the left anterior bladder wall was then made and a large broad based ulcerating carcinomatous growth was found located in the left bladder wall. The ureteral orifices and other parts of the bladder were free. An oval section surrounding the growth was then excised through the entire thickness of the bladder wall. The bladder was closed in one layer and a drain was placed in the prevesical space. The abdomen was closed in layers.

Histological examination showed carcinomatous infiltration of the musculature. The form of the epithelium spoke strongly for malignant papilloma.

At the end of 17 days the patient was discharged from the hospital in good condition. The wound was well healed the urine was clear and could be retained for about 3 hours.

#### CASE 2. Diagnosis carcinoma of the bladder

M. W. a man aged 66 years complained for the past 2 years of painful micturition and hematuria and showed at cystoscopic examination an ulcerating growth on the posterior bladder wall extending down to and involving the trigone. The ureteral orifices could not be definitely made out inasmuch as they appeared to be overgrown by the tumor. The mucosa surrounding the tumor was very hyperemic and edematously thickened.

Operation. The bladder was exposed by the Bardenheuer transverse abdominal incision and following extraperitonealization a definite infiltration of the posterior bladder



wall could be felt. A small opening was made anteriorly and a tumor the size of a 50-cent piece was seen to occupy part of the posterior wall and almost the entire interspace of the trigone between the ureteral orifices. Probes passed up the ureters showed them to be free. The tumor had a crater form ulcerated center and had already infiltrated the bladder wall a depth of about 1 centimeter. It was evident that to carry out a radical resection would surely lead to difficulties with the ureters. With the patient's general condition below par, his advanced age, the possibility that a radical resection might necessitate a bilateral reimplantation of the ureters, it was therefore decided to renounce the radical procedure. With a sharp curette the ulcer was thoroughly scraped out and the base cauterized. An indwelling catheter was inserted through the urethra. The bladder was closed with one layer of catgut. A drain was placed in the space of Retzius and the abdomen was closed in layers. Histologically the tumor was a squamous cell carcinoma.

At the end of 23 days the patient was discharged from the hospital in good condition; the wound was well healed and the urine was clear.

**CASE 3.** Diagnosis: *diverticulum of the bladder; sclerosis of internal phincter.*

**K.** A man aged 66 years complained for the past 3 years of frequent painful micturition, turbid urine and occasional terminal hematuria. For the past 6 months he had had urinary retention requiring catheterization two and three times daily. At the age of 20 he had had a venereal infection that had induced a stricture of the posterior urethra and bladder neck for which he had had dilatation. Cystoscopy showed a diverticulum opening into the posterior bladder wall just above the trigone; which finding was confirmed by cystography.

**Operation.** A Bardenheuer transverse abdominal incision was used. The bladder was then extraperitonealized according to the method of Voelcker. Through a small incision in the vertex the opening of the diverticulum was found in the posterior wall just above the trigone. Due to the complete mobilization of the bladder achieved through the extraperitonealization, excellent approach was had to the posterior wall of the bladder. The neck of the diverticulum was resected and the resultant opening in the bladder was closed with a single layer of catgut. However the sac proper was located rather deeply between the rectum and the bladder and was so firmly adherent that it could be removed from the rectum only by means of sharp dissection which was successfully accomplished without injury to the latter. Following the diverticulectomy examination of the bladder phincter showed it to be sclerotic and inelastic. This obstruction in all probability explained the etiology of the diverticulum. The phincter was so incised as comfortably to allow a finger to be inserted in the posterior urethra. The bladder was drained from above through a large tube sewed into the opening in the vertex which had been made at the beginning of the operation and the bladder edges were then sewed watertight around it. The diverticulum bed was also drained. An indwelling catheter was passed to the bladder through the urethra. The abdomen was closed in layers.

At the end of 8 days the patient was discharged in good condition. The wound was well healed; the urine was clear and he could urinate spontaneously without pain.

**CASE 4.** Diagnosis: carcinoma of the bladder.

**M.** A woman aged 55 years complained for the past 2 months of painful micturition and constant gross hematuria. Cystoscopic examination revealed an ulcerating tumor in the posterior wall extending almost to the ureteral orifices which, although thickened with edema, appeared to be uninvolved.

**Operation.** Bardenheuer transverse abdominal incision was used. Extraperitonealization of the bladder according to Voelcker was then attempted. However after the anterior peritoneal incision had been made it was discovered that the greater part of the posterior wall of the bladder was invaded by a tumor which had also invaded the peritoneal covering over a large area. By means of careful palpation it was found that even below this peritoneal fold the tumor was adherent to the uterus. Apart from its adherence to the uterus the tumor was still movable and no metastases appeared to be present so that its resection was still possible. Before proceeding with this however the completion of the extraperitonealization of the bladder was undertaken. Because of the complicating infiltration into the peritoneal fold covering the vertex and posterior bladder wall this had to be accomplished in a somewhat modified manner. A transverse incision was therefore made in the peritoneum covering the anterior wall of the uterus just proximal to the point where it duplicates and the peritoneal flap so won was reflected upward and sewed with the anterior peritoneal margin thus closing off the peritoneal cavity. By means of scalpel the tumor was then sharply separated from the uterus and the bleeding uterine musculature was brought together with a row of catgut sutures. The tumor was then completely removed by excision of the involved section of the posterior bladder wall. The bladder was first sutured posteriorly lengthwise but after four or five sutures the tension became excessive. Therefore the left half of the bladder of which there had remained more than the right was pulled over and sewed on with transverse continuous sutures so as to form the roof. In this manner the bladder was completely closed. A drain was placed in the space of Retzius and an indwelling catheter was inserted through the urethra.

Examination of the specimen showed that the tumor was about 7 by 7 centimeters wide and about 2 centimeters thick, with its mucosal surface extensively ulcerated. Histologically it was a squamous cell carcinoma.

At the end of 23 days the patient was discharged in good condition. The wound was well healed. The urine was clear and could be retained about 4 hours without difficulty.

**CASE 5.** Diagnosis: carcinoma of the bladder.

**N.** A man aged 63 years complained for 14 days of frequency and hematuria. Cystoscopic examination revealed an ulcerating growth on the right bladder wall. Cystography showed a defect of the right bladder wall.

**Operation.** A Bardenheuer transverse abdominal incision was carried more to the right than to the left. The bladder was then extraperitonealized according to the method of Voelcker. Following this mobilization of the bladder an extensive infiltration of the right wall could be definitely palpated whereas previous to the extraperitonealization this could not be clearly felt. An opening in the right anterior bladder wall was then made and a bleeding broad-based carcinoma like tumor about the size and form of a hen's egg was found located in the right posterior wall which was deeply infiltrated. The tumor extended just above the right ureteral orifice. The tumor with a liberal portion of the surrounding bladder wall was resected in the form of an oval flap. The bladder was closed with a single layer of catgut. An indwelling catheter was passed to the bladder through the urethra. A drain was placed in the space of Retzius. The abdomen was closed in layers.

Examination of the specimen showed an extensive ulceration of its mucous surface. Histologically it was a squamous cell carcinoma.

At the end of 18 days the patient was discharged from the hospital in good condition and with no complaints. The urine was clear and could be retained about 4 hours without difficulty.

The purpose of this paper is not to report a large number of cases or to discuss the detailed treatment of neoplasms of the bladder, rather the technique of a method and a few cases illustrating its application are given in an attempt to show the usefulness of the Voelcker extraperitonealization of the urinary bladder as a preliminary step to such major operative procedures on the bladder as resection, diverticulectomy and total extirpation. The value of this method can best be judged if one considers the excellent approach that was obtained to the different parts of the bladder which were involved in these cases and the comparative ease with which these usually difficult operative procedures could thereby be accomplished. In Case 1, the tumor was in the left lateral wall, in Case 2, the tumor was in the bladder fundus, in Case 3, the diverticulum was in the posterior wall just above the trigone, in Case 4 the tumor was in the posterior wall and had invaded the uterus and the peritoneum covering the posterior wall of the bladder, in Case 5 the tumor was located on the right posterior wall.

Inasmuch as most bladder tumors have their origin in the region of the bladder floor, a complete mobilization and exposure of the posterior bladder surface is of utmost importance because of the possibility thereby offered to operate more radically and more easily. In the case of broad based and infiltrating tumors a section of the entire bladder wall should be removed. The end results of operations for cancer of the bladder have confirmed such radical procedure in the experience of most surgeons (1, 4, 5, 7, 10, 13).

It is obvious of course that this method when compared to the usual transperitoneal method, also offers a better and safer means of judging the operability of tumors or the presence of metastatic infiltrative processes into the neighboring organs before the actual surgical procedure on the bladder is begun. The operation can thus be timely discontinued, thereby avoiding both a useless operation and also the opening of the bladder with the risk of contaminating the peritoneal cavity.

It should also be pointed out that here, as in the transperitoneal method the peritoneal opening can be utilized in the seeking for abdominal metastases. Judd cites two cases in which extensive metastases were found in the liver and in the pelvic peritoneum thus making the contemplated radical operation unnecessary (6).

The decision as to whether just a simple suprapubic cystostomy or extraperitonealization is indicated depends mainly on the cystoscopic findings. With the exclusion of cases that are amenable to endovesical treatment, the ordinary extraperitoneal suprapubic exposure should suffice for the ordinary cases, such as stone, foreign bodies, tumors of the anterior bladder wall and pedunculated growths in the other walls of the bladder. In all other cases in which the operation takes the form of a resection and has to extend over into the superior, posterior, and lateral walls of the bladder or in cases in which the extent of the pathological process cannot be cystoscopically, definitely defined previous to operation, then the method of choice is the suprapubic exposure plus extraperitonealization of the bladder, inasmuch as this method allows a critical survey of the entire field before the actual procedure on the bladder. Moreover, it fulfills the requirements necessary to operate on any part of the bladder without complicating the operative procedure.

#### BIBLIOGRAPHY

1. ANDRÉ I. Les interventions pour tumeurs de la vessie et leurs résultats. *Rev. méd. de l'est* 1924 III 715.
2. BICKHAM W. S. *Operative Surgery* Vol. V p. 596 Philadelphia W. B. Saunders Company 1924.
3. BLUM V. Ueber Extraperitonisation der Blase nach Voelcker zur Erleichterung von Blasenoperationen. *Ztschr. f. urol. Chir.* 1922 VIII 146.
4. RIGGIE H. G. Report of cases of malignant growths of the bladder treated by resection and radium. *J. Urol.* 1923 X 159.
5. FRONTZ W. A. Consideration of bladder tumors with special regard to the therapeutic measures best suited to the different types. *Surg. Gynec. & Obst.* 1928 XLVII 413.
6. JUDD I. STARR. The transperitoneal operation for removal of bladder neoplasms. *J. Am. M. Ass.* 1909 LIII 2146.
7. Idem. The treatment of carcinoma of the bladder by radical surgical methods. *J. Am. M. Ass.* 1916 LXXXVI 1620.
8. LICHTENBERG A. & VOELCKER F. and WILDBOLD H. *Handbuch der Urologie* Vol. 2 p. 211 Berlin Julius Springer 1926.
9. *Ibid.* Vol. V p. 214 1928.
10. LICHTENBERG A. V. Die chirurgische Behandlung der bösartigen Blasengeschwülste. *Klin. Wchnschr.* 1927 VI 459.
11. REBERTUS H. Zur Operation hieselzenden Uretersteine. *Ztschr. f. urol. Chir.* 1925 XVII 245.
12. RUDOLPH L. R. V. Zur transperitonealen Freilegung der Blase. *Centralbl. f. Chir.* 1909 II 372.
13. SOLIER J. BENTLEY. Segmental resection of the bladder for neoplasm. *Surg. Gynec. & Obst.* 1923 XXXVII 179.

ALCOHOL INJECTIONS FOR POSTOPERATIVE PAIN  
IN THORACIC SURGERY<sup>1</sup>

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**A**LLEVIATION of painful conditions by blocking the nerves with alcohol has been practised for a number of years. Affections of the trigeminal nerve and its divisions particularly the second and third have thus been treated with remarkable success. Attacks of angina pectoris have also been greatly benefited by alcoholization of the upper thoracic nerves at their exits from the intervertebral foramina. Injections of alcohol and cocaine in varying proportions have improved the condition of many patients suffering from sciatica. A recent development in thoracic surgery is the blocking of the thoracic nerves to alleviate postoperative intercostal neuralgia.

The literature is silent on the use of alcohol injected after operation for the relief of intercostal neuralgia in thoracic surgery.

Among the diseases of the chest requiring surgical intervention is pulmonary tuberculosis in the stages of abscess cavities, hemorrhage, or empyema. For such cases, the consensus of opinion is that pulmonary compression offers the best prospect of improvement and in a great percentage of them the only hope of a cure.

All forms of surgical treatment tend toward the achievement of procedures by which the diseased lung can be collapsed and compressed in whole or in part and the empyema obliterated. The methods by which a complete pulmonary collapse may be achieved are artificial pneumothorax and extrapleural thoracoplasty. A partial collapse is obtained by phrenicectomy and by pneumolysis. It is in the relief of pain occurring after extrapleural thoracoplasty that we are particularly concerned in this paper.

Extrapleural thoracoplasty is a major operation which when indicated is done in two, three or more stages. It involves the resection of the first to the tenth or eleventh rib, secondary removal of longer segments or ribs previously resected and total costatectomy. In most of these cases the pleura is thickened and structural changes are present in the ribs incident to cicatricial contraction. This is particularly true in cases of effusion of long standing. Repeated operations upon the same ribs with the object of removing longer segments have a tendency to increase the grade of thickening and the extent of cicatricial repair. Although subperiosteal

resections are usually performed the intercostal nerves may be traumatized or included in scar tissue formation and thus result in painful conditions.

The process however may be altogether different and one of the nerves may be exposed to irritation by a drainage tube perhaps as a result of progressive erosion or sloughing off of the parts in which the nerve used to be embedded. Maintenance of the tube as a necessity may be so painful as to render it intolerable.

Postoperative pain and intercostal neuralgia are well known sequelae of thoracoplasty, as evidenced by the constant attempts to minimize their occurrence and severity. The avoidance of trauma to the intercostal nerves, vessels and muscles eliminates postoperative pain and lessens the chances of later intercostal neuralgia. Alexander believes that the use of such instruments as the Doyen respirator is of great advantage in eliminating such trauma.

All methods hitherto employed to lessen postoperative pain involve the temporary impairment or permanent destruction of the nerves in the course of thoracoplasty. Wilms crushed the intercostal nerves. Davies and Hedblom inject a few drops of 80 per cent alcohol around or into each nerve as far posteriorly as possible. Jensen, Stocklin and Muhsam resect from 1 to 2 centimeters of each nerve sometimes together with a section of the overlying periosteum. Sauerbruch resects similar lengths in patients with thickened and oedematous periosteum. His experience being that otherwise they are apt to suffer from intercostal neuralgia. On the other hand Braver has never met with postoperative intercostal neuralgia.

The permanent destruction of nerves in the course of the operation is less commendable than their temporary impairment by the injection of 80 per cent alcohol as practised by Davies and Hedblom. Extensive alcoholization may however result in paralysis of important muscles, the function of which it is wise to preserve. Although paralysis of the abdominal wall has not been reported as harmful resections and alcohol injections of the lower intercostal nerves should be avoided. Hug has found that patients in whom the lower intercostal nerves have been paralyzed show a bulging of the abdominal

muscles of the same side, especially of the epigastrum and costal border. Some of them need the continuous support of an abdominal bandage.

Paralysis of one half of the most important muscles used in expectorating cannot, in the opinion of Alexander, be considered harmless in view of the relatively high incidence of stasis pneumonia following thoracoplasty. Further more the bulging of the costal margin as a result of paralyzing the lower intercostal nerves, partially defeats the aim of rib resections by decreasing to a certain extent the amount of lung compression. It would seem plausible, therefore to discontinue the practice of destroying the intercostal nerves deliberately in the course of thoracoplasty and to inject alcohol only in those cases of neuralgia diagnosed after operation.

Alcohol injections should be made only after scrupulous analysis of anatomical conditions and correct diagnosis of the nerves involved. Resection of the ribs flush with, or at short distances from, the transverse processes destroys their main support, tends to change the position of the ribs, and disturbs landmarks. Removal of large segments of the first ribs causes morphological displacements of all the structures of the hemithorax. Repeated operations involving the lower ribs exaggerate the anatomical distortions already present. The picture is so changed that laterally the ribs appear almost vertical when viewed from the front (Figs 1 and 2).

These distortions of the bony framework are reflected on the nerves also, and it needs careful exploration to define the nerves along which stimulations of deeply seated structures are carried to peripheral areas of the skin.

A remarkable method of diagnosing the nerves supplying the region to which the pain is referred consists in examining the X-ray pictures and comparing them with the patient. Measurements are taken from the painful area to well defined bony landmarks on the same side and are superimposed on the X-ray pictures (Fig. 2).

Corrections are made for differences in size between the patient and the picture and the intercostal spaces recorded in front. By counting the spinous processes downward it is possible to arrive at a fairly accurate diagnosis (Fig. 3).

Injection of the nerves in the intercostal space is of little value if any because landmarks are missing as a result of rib resection. The only practical method is that of paravertebral block by which the nerves are injected close to the spinal column. It may be necessary to inject one nerve above and one nerve below those already injected.

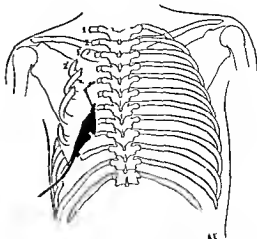


Fig. 1. Outline of the bony framework drawn from a roentgenogram showing the degree of collapse of the lateral wall and the extent of the downward displacement of the first two ribs 1-1 2-2 in particular.

This should be done only after making sure, by testing the field, that the area of anesthesia first obtained is not wide enough to give complete relief. Stress must be laid on the wisdom of restricting the block to the desired region, because alcoholization is followed by very long periods of numbness which may cause discomfort if the numbness covers an extensive area.

The use of 95 per cent alcohol in the treatment of trigeminal neuralgia gives better results than when 80 per cent alcohol is injected, probably because the nerves are blocked by the extraneural method. Similarly in paravertebral block, the higher the percentage of alcohol the deeper the anesthesia and the longer the period of relief. Injection of 3 cubic centimeters at each nerve is quite sufficient.

The landmarks are, as usual, the spinous processes of the dorsal vertebrae. If the nerves to be injected are among the upper six, it is best to define the prominent seventh cervical spine and count the dorsal spines from above downward. If the injections are to be made lower than the sixth nerve it is preferable to count the spinous processes by starting from the twelfth dorsal spine which is defined as follows.

The middle line of the back and the direction of the twelfth rib on the uncollapsed side are traced on the skin by means of small applicator moistened with tincture of iodine. These lines generally meet at the tenth dorsal spine and include an acute angle. Of all the perpendiculars dropped from the twelfth rib onto the middle line of the back, that which measures 5 centimeters



Fig 2 Roentgenogram with the painful area plotted according to mensuration taken on the patient. The cross marks the region of skin radiations of pain induced by introducing the tube.



Fig 3 Roentgenogram of the back showing the stumps of the ribs and the extent of the resections. Note the morphological displacements of the hemichest.

marks the level of the twelfth dorsal spine (Fig 4).

Wheals are raised with 0.5 per cent neocaine solution opposite the selected spinous processes at a distance of 4 centimeters. If the scar marking the line of incision is in the way, the wheals should be made lateral to it as it is preferable to approach the deep structures in an oblique direction (Fig 5). The Labat needle (80/8) is passed through the wheal in a direction normal to the surface of the skin and introduced toward the stump of the resected rib with which it comes in contact at a depth of from 2 to 3 centimeters. The needle is then partially withdrawn and reintroduced downward inward and forward 45 degrees in all directions, until the point of the needle is 5 centimeters deeper than the point at which contact was made. The injection is then made without displacing the needle.

Pain may be experienced while maneuvering the needle through the slice of scar tissue formed in the plane of the surgical incision. It is not advisable to inject neocaine before the alcohol because such a procedure blunts sensibility, may prevent the induction of parästhesias along the selected nerves and thus defeat the aims of the injection technique. The relief is instantaneous and complete when the injection is made following parästhesias in the territory of the original pain.

The technique is fraught with difficulty when the ribs have been resected flush with the trans-

verse processes. In this case the needle loses its best guide, which is the rib and must rely on the transverse process which is more superficially situated. Care must be exercised not to slant the needle too much for fear of making the injection over the laminae or passing between them, thus, in the first case serving no purpose and in the second making an intraspinal injection. The needle should in its first thrust through the wheal be slightly inclined inward so as to make contact with the transverse process.

Mrs G E W was referred to Dr Lilenthal in September 1928. She had been ill for a number of years certainly since February 1923. Then a diagnosis was made of tuberculosis of the entire left lung. Artificial pneumothorax in July 1923 was about 90 per cent successful owing to adhesions in the upper chest with cavity formation. This collapse became reduced to only about 50 per cent. Several times fluid had appeared in the pleura which absorbed and reappeared. The pleura became extremely thick. A sample withdrawn by needle was opaque but contained no tuberculosis bacilli. Cough and expectoration had been constant from the beginning but had diminished until May 1928 the case seemed to have been arrested and the patient married. Within a month there was sudden fever and it became necessary to drain the left chest which was done by thoracotomy with resection of the eighth rib. Meanwhile the right lung although it showed evidence of diffuse infection had remained stationary and the process here appeared to be arrested. After temporary relief the fever again rose to 103 degrees F and she came to New York where Dr Lilenthal first saw her about December 15 1928. On examination it was observed that the drainage of thick pus was insufficient and this was corrected by changing the tube.

Her general condition was good and fever had been moderate for some days. There were evidences however of pleuropulmonary fistula. It was decided after an X ray examination with lipiodol instilled through the fistula that a large empyema cavity existed and there was in any event a discharging cavity in the upper lobe of the left lung. It was evident that nothing short of a complete surgical collapse of the chest wall on the left side would promise to obliterate both the pulmonary and the pleural cavities. This was carried out in two stages both operations being performed with the aid of general anæsthesia by nitrous oxide and oxygen administered by Dr William Branower. The first stage was on December 20 when sections of the first to the fifth rib were removed about 16 inches in all. At the same time a second drainage opening was made by removing about an inch of the tenth rib together with its periosteum in the posterior axillary line (see Fig 6). The operation was well borne the blood pressure 2 days later being 116-70. The healing was prompt and by January 10 1929 there was very little cough and the temperature was normal. On January 14 the patient was again operated on. A free incision was made in the seventh interspace and long sections of the sixth, seventh and eighth ribs were removed. The fifth rib was also shortened by further section of the divided ends. So much of the bony chest wall was thus removed that when compression was made from without the walls of the empyema cavity almost touched. A large tube with a finger cut valve was placed through the lower drainage opening and it functioned well after the edges of the upper drainage opening had been drawn together with plaster. Following this second procedure there was for about a week a stormy time principally however on account of the apprehensiveness of the patient. Another test was made on January 30 by the injection of an aniline dye through the pleura. The color appeared with the sputum in a few hours. The cough was the least of our troubles says Dr Lilienthal. The actual quantity of mucopurulent expectoration amounted to about 5 to 8 cubic centimeters a day. As a therapeutic measure a transfusion of 400 cubic centimeters by the direct method was performed by Dr Nathan Rosenthal. Following a rather sharp reaction there was rapid improvement and by the first of March Dr Lilienthal would have sent this patient back to her home except that there was one difficulty. Any slight motion of the chest while the tube was in place produced pain in what was supposed to be the distribution of the eighth or perhaps the seventh intercostal nerve. The pain was very severe whenever the tube was withdrawn or inserted because of the internal fistula. It was absolutely necessary for the patient to wear a tube for drainage until the fistula closed which it was hoped would occur. Because of the extreme anatomical deformity of the bony chest wall it was almost impossible to judge exactly which nerves were being irritated by the tube. Dr Lilienthal made one attempt to inject alcohol into the intercostal structures behind what appeared to be the painful region but without success. It was at that stage that I was called upon for counsel. We saw the patient on Monday March 4 1929 and after carefully examining the chest and inspecting the X ray pictures I suggested that it would be advisable to attack the appropriate nerve roots with the hope of permanently blocking the entire region about the drainage fistula. The fourth, fifth and sixth thoracic nerves were injected with 95 per cent alcohol. This was done on March 5 in the patient's room in the presence of Dr Lilienthal. Immediately after the injections Dr Lilienthal tested the result of the injections. He inserted the tube without the knowledge of the patient. He removed it and replaced it several times with

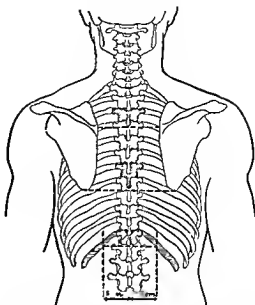


Fig 4 Landmarks of the dorsal vertebra. With the arms alongside the body the horizontal line passing through the spine of the scapula marks the spinous process of the third dorsal vertebra that drawn at the level of their inferior angle passes between the seventh and eighth dorsal spines. The perpendicular measuring 5 centimeters dropped from the twelfth rib on the midline of the back marks the spinous process of the twelfth dorsal vertebra (From *Regional Anesthesia* Saunders)

no expression of pain on her part. Relief was complete and Mrs W. went home a few days later in perfect comfort so far as her surgical wound was concerned. On March 15 I received word that the patient was entirely free of pain. The prognosis of this case seems excellent even though it may be necessary for a tube or plug to be worn for a considerable time.

It is expected that anæsthesia will last for months and perhaps until nature shall have provided adequate protection against irritation by the tube. Even if our expectations fail to realize themselves, there is still left the expediency of resecting the nerves with alcohol.

The incidence of postoperative pain or intercostal neuralgia associated with thoracoplasty must be extraordinarily great since particular care is taken by most surgeons to impair the nerves or destroy them at the time of the operation. It has been shown that the effects of such wide destruction are not altogether harmless when the lower intercostal nerves are concerned. Furthermore it has been observed that not all the nerves are influenced by unintentional surgical trauma or involved in cicatricial repair or become exposed to irritation as a result of destructive pathological processes. It would, therefore, seem advisable to leave the nerves intact in the



Fig 5 Drawing from nature showing the sites of injection and the area of numbness following alcohol injections of the fourth fifth and sixth dorsal

course of the operation and institute treatment in the occurrence of postoperative neuralgia. In this manner it would be possible to save many nerves particularly the lower intercostal nerves which supply muscles the function of which is considered most valuable in the act of expectoration.

Injection of the brachial plexus can be made with weak concentrations of alcohol without marked impairment of the motility of the upper extremity. After careful analysis of the affected branch one root of the plexus can be injected by the paravertebral method. If the entire plexus should be involved there is no objection to injecting it with alcohol and neocaine in certain proportions, since these drugs have a greater affinity for sensory than for motor nerves. If motor function should be reduced as a result of the loss of conductivity special training of the central nervous system would in time restore efficiency.

There are many other types of postoperative neuralgia which would be greatly benefited if treated by alcoholization of the affected nerves. Perhaps greater is the number of patients suffering from incurable diseases who are given morphine daily for the alleviation of their suffer-



Fig 6 Photograph showing characteristic scar of upper thoracoplasty and the more unusual intercostal incision for the lower half of the operation. The tube is air tight. It is fitted with a rubber valve which is protected by a bag of gauze into which the small quantity of drainage flows.

ings. Alcohol injections would be welcomed by those patients.

The author wishes to extend to Dr. Lilienthal his sincere thanks for this history and the expression of appreciation for the great privilege of reporting this case. To the patient Mrs. G. E. W. we are particularly grateful for her kind permission and valuable co-operation.

#### BIBLIOGRAPHY

- ALEXANDER JOHN: The Surgery of Pulmonary Tuberculosis. Philadelphia: Lea & Febiger 1922 p. 122.
- BRACER L.: Das Ziel und die Abarten der extrapleurale Thorakoplastik. Beitr. z. Klin. d. Tuberk. 1922 II 319.
- DAVIES H. M.: Quoted by Alexander.
- HEDBLOM C. A.: The graded operation in thoracic surgery. Surg. Gynec. & Obst. 1923 XXXVII 91.
- HIGGINS OSCAR: Thorakoplastik und Skoliose. Beil.-heft Ztschr. f. orthop. Chir. 1921 VII 5.
- JESSEN F.: Die operative Behandlung der Lungentuberkulose. 3d ed. Leipzig: Curt Kabitsch 1921.
- LARAT G.: Regional Anesthesia. 2d ed. Philadelphia: W. B. Saunders Company 1928.
- MILBAM R.: Ztschr. f. ärztl. Fortbild. 1910 XVI 422.
- STOCKEN H.: Beitrag zur Behandlung der Lungen Tuberkulose mit extrapleurale Thorakoplastik. Beitr. z. Klin. d. Tuberk. 1922 II 350.
- WILMS MAX: Die Fortschritte in der operativen Behandlung der Lungentuberkulose. Deutsche Ztschr. f. Chir. 1914 CXXX 64.

## MICROMELIA IN A CHILD IRRADIATED IN UTERO

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ACCORDING to recent studies by the authors (3, 4, 5, 6, 8, 9), therapeutic maternal pelvic radium or roentgen irradiation during pregnancy is extremely likely to injure the fetus. Microcephaly is the defect most commonly produced; e.g., of 76 children irradiated *in utero* 19 (25 per cent) were reported as being microcephalic idiots.

Other developmental disturbances were also observed among the irradiated children. Three of them exhibited congenital malformations of the extremities, brief descriptions of which are presented in Table I.

Another case of deformity of the extremities in a child irradiated *in utero* is reported in this paper. This gives us a total of 77 irradiated children, 4 of which (5 per cent) manifest malformation of the limbs. The following case is reported because of the possible importance of the irradiation as a cause of the arrested development.

## CASE REPORT

Mrs. X, who had previously given birth to 2 healthy children, developed metrorrhagia at the age of 40 years. This condition was attributed to a menopausal disturbance and roentgen therapy was accordingly advised.

Without a preliminary curettage a series of therapeutic roentgen exposures was begun. The last normal menses occurred on February 22, 1926, at about which time conception probably took place. The first roentgen treatment was given on April 16 during the second month of gestation. Fetal movements were felt for the first time on July 3. Three days later the last roentgen treatment was administered. Details of the course of treatment are given in Table II.

On December 4, 1926, or 5 days before term, a stillborn female child was delivered without difficulty.

*Description of child.* The deformed fetus was preserved as a pathological specimen. On May 1, 1927, it was examined, but since autopsy was denied only superficial examination and roentgenographic studies were possible.

As will be observed from a study of the accompanying photograph (Fig. 1) the head and trunk appeared to be

well proportioned and not grossly deformed. The extreme shortness and deformity of the lower extremities and the less marked shortness of the upper extremities, however, gave the impression that the trunk is abnormally long.

The roentgenogram (Fig. 2) discloses the absence of 2 long bones in each of the lower extremities. Dr. Henry K. Paoceast, who examined the film, stated as his opinion that the one long bone present in each extremity was in all probability the tibia.

This case of micromelia (congenital shortening of the extremities) with absence of several of the long bones in the lower extremities, suggests irradiation as the cause of the arrested development. The correctness of this assumption cannot, however, be definitely determined as deformities of this type, sometimes, although very rarely, occur in non irradiated children. Since radiation may arrest the development of the central nervous system, the possibility that it may also arrest the development of other organs must, however, be seriously considered.

In a survey of 81,000 births made by Mall (7), there were 115 children with deformed extremities, which is equal to a deformity rate of 0.14 per cent. This rate is one thirty-fifth of that (5 per cent) found in the group of children irradiated *in utero*. The high deformity rate in the latter group, as compared with the rate in the case of the non irradiated children, strongly suggests the irradiation as the etiologic factor.

If fetal irradiation will arrest development, how may such an accident be prevented? The answer lies in the careful adherence to one procedure, namely preliminary curettage. This operation performed before the employment of pelvic radium or roentgen irradiation, would destroy any unsuspected embryo and consequently prevent the birth of a damaged child. It would also disclose the exact pathological condition of the uterine mucosa, and would reveal the existence of

TABLE I. CHILDREN, IRRADIATED IN UTERO SHOWING DEFORMITIES OF THE EXTREMITIES

Author	Description of the deformities
1. Bailey II	
and Bagg II	Spina bifida and club feet
2. Fellweg P	Deformities of both forearms; absence of both radius; arms dislocated externally at elbow joints
3. Ries F	Hydrocephalus; absence of right forearm; absence of 2 fingers on right hand; abdominal malformations

TABLE II. DETAILS OF ROENTGEN TREATMENT

No. of treatment	Date	Time of exposure in minutes	Miliamperage	Potential (k.v.)	Filter mm.	Focal distance in.	Area
1	4-10-26	30	4	200	1/2 Cu	15	2 ant.
2	4-10-26	9	4	85	4 Al	10	6 post.
3	5-7-26	20	4	85	1 Al	10	6 ant.
4	5-11-26	10	4	85	4 Al	10	6 post.
5	6-4-26	8	4	100	1/2 Cu 1 Al	15	6 ant.
6	6-8-26	8	4	100	1/2 Cu 1 Al	15	6 post.
7	7-9-26	8	4	100	1/2 Cu 1 Al	15	6 ant.
8	7-12-26	8	4	100	1/2 Cu 1 Al	15	6 post.

Coolidge tube Wappler machine





Fig 1 Photograph of stillborn female white child which was exposed to therapeutic roentgen irradiation from the second to the fifth months of fetal life while the mother was being treated for menopausal hemorrhage. Note the shortness and deformity of the lower extremities.

fundal carcinoma so often overlooked in the radiological treatment of pelvic disease characterized by hemorrhage (10).

It might also be stated here that instances are known to the authors (5) in which conception has taken place in the interval between two of a series of roentgen exposures without the knowledge of the radiologist. Therefore when a series of roentgen exposures is being undertaken the patient should be warned of the danger of becoming pregnant during the course of treatment.

#### CONCLUSION

On the basis of this study we believe that therapeutic pelvic roentgen irradiation during preg-



Fig 2 Roentgenogram of child shown in Figure 1. Note the presence of only one long bone in each lower extremity.

nancy may arrest the development of the bones as well as that of the central nervous system.

#### BIBLIOGRAPHY

1. BAILEY H. and BACC H. L. *Am J Obst & Gynec* 1923 v 451-4,3.
2. FELDWEG P. *Strahlentherapie* 10 xxvi 99-101.
3. GOLDSTEIN L. and MURPHY D. P. *Am J Obst & Gynec* 1929 xxix 180-193.
4. Idem. *Am J Roentgenol & Radium Therapy* 1929 xxx 3 351.
5. GOLDSTEIN L. and MURPHY D. P. *Am J Obst & Gynec* 1929 xxix 690-695.
6. GOLDSTEIN L. *Radiogenic microcephaly: a survey of 19 recorded cases with special reference to ophthalmic defects.* In press.
7. MALL F. P. *J Morphol* 1908 xxx 3 368.
8. MURPHY D. P. *Ovarian irradiation: its effect on the health of subsequent children, etc.* *Surg Gynec & Obst* 19 3 xliii 61-215.
9. Idem. *Ovarian irradiation and the health of the subsequent child, etc.* *Surg Gynec & Obst* 19 9 xliiii 66-3.
10. N. REI C. C. *Am J Obst & Gynec* 19 3 vi 1.
11. KIL E. *Am J Obst & Gynec* 19 6 xi 361-373.

## LIPOSARCOMA OF THE MAMMARY GLAND

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**T**UMORS composed of tissue resembling embryonic connective and fat tissue do not occur frequently. Since Robertson's review of the subject, in 1916, a moderate number of similar benign and malignant growths which have been located in various organs and structures of the body have been reported. It is to be noted that by far the most frequent sites of predilection are the lower extremities (Jacobson, Ewing, Jaffe, Schiller) and the retroperitoneal space (Wells and Hirsch, Salzer), that is, in those parts of the body where the amount of fat is greatest. The mesentery (Turner, Waldeyer, Madelung), kidney (McConnell, Harbitz), muscles of the forearm (Stich), face (Senfleben), pleural cavity (Barbier and Mollard), lumbar dura mater (Caldwell and Zininger), uterus (Springer), suprarenals (Schwarz), midline of the back (Razor), shoulder (Comells), mouth and nose (Stanze), and the face with involvement of the neck have all been recorded as the occasional situation of this type of neoplasm.

These tumors are regarded as being of moderate malignancy because there is, usually, a well defined capsule, growth is slow, and they are freely movable in the surrounding tissues. However there is a marked tendency to recurrences and, occasionally, metastases occur to the lungs, mediastinum, subcutis, and the joints (Ewing). Also a marked xanthomatous quality is not often associated with a malignant course. Severe complications at times, may result such as pressure upon adjacent vessels and nerves with subsequent alteration of the organs supplied. In addition dilated and tortuous veins frequently course over the mass, and this factor in the presence of infection, ulceration, abscess or gangrene predisposes to sepsis particularly when surgical procedures are performed.

Other neoplasms may closely simulate a liposarcoma and therefore certain restrictions must be made in making this diagnosis. In fact, the existence of the group of new growths under discussion was much doubted by Ribbert and Schwalbe. Sarcoma arising from the connective tissue of a lipoma is well illustrated in the case of Schiller in that a tumor of fat had been present in the breast of a woman for 6 years and after this period a sarcoma developed in the scar tissue which had formed after the removal of the benign mass. Jaffe calls attention to the observation that

new growths which are associated with cartilage, bone, or myxomatous tissue give rise to atypical structures which may resemble the histological picture of liposarcomata. Mixed tumors, too, may contain considerable amounts of fat, but here the fat plays only a passive rôle. Immature fat cells are frequently abundant in rapidly growing lipomata, but this represents simply the means of growth, for adult fat cells do not have the power to proliferate.

Embryologically, these neoplasms have repeatedly stimulated the study of the still unsolved problem of the origin of the fat cell. Keibel and Mall believe that the mesenchymal tissue differentiates into blood vessels, supporting fibrous tissue and fat cells. They describe the process as follows: small granules appear in the cytoplasmic cellular substance which form into fat bodies, consolidate, and then become transformed into solitary lipid masses which are then covered by a protoplasmic membrane. Jordan and Kindred state that the lipoblast is a mesenchymal cell in which fat globules are being elaborated in the following manner: There is first a budding of the chromatin substance of the nucleus with extrusion of the granules through the nuclear membrane. These granules are the primary fat bodies which gradually coalesce forming large drops of fat. Lewis and Stohr noted that in the 4 months' fetus, the fat cells are like the surrounding fibroblasts. Maxumov considers the fat cell as being derived from the fibroblast.

The histogenesis of the fat cells and the mucin have given rise to considerable thought in relation to liposarcomata. Robertson submitted this question: 'Do the lipomatous portions represent a fatty degeneration of the myxomatous tissues or vice versa?' He regarded each substance as a modification in the differentiation of mesoblastic cells and therefore as an independent type. Mallory maintains that the fat cell is a distinct type formed by differentiation from a mesenchymal cell and that it does not form a fibroblast. Jaffe regards the close relationship between mucinous and fat tissue during embryonic life as significant in these tumors composed of embryonic connective and fat tissue.

The case of Wells and Hirsch revealed some very interesting findings. Although the man was markedly emaciated, the retroperitoneal tumor



Fig 1 One of the multiple transverse sections through the mammary gland showing two of the largest tumor masses replacing the greater portion of the breast. A well defined line of demarcation divides the nodes from the mammary substance.

weighed 69 pounds, the largest on record. Chemical examination revealed 2 pounds of fatty material and  $4\frac{1}{2}$  pounds of protein. There was a greater amount of sulphur, phosphorus and nitrogen than in the granuloma of swine. This latter fact, the authors believe, indicates that the tumor tissue is more embryonic than inflammatory.

The case to be reported presents several interesting features in that the tumor was located in the breast, a very rare, if not previously unrecorded location. Also it was very malignant and occurred while the mother was nursing her child thus affording an opportunity for the differential diagnosis of the so called lactation tumors.

#### CASE REPORT

An Italian woman aged 41 years entered the surgical service of Dr. Raymond McNealy on June 3, 1923. She stated that she had given birth to a healthy baby 10 months before coming to the hospital. It was not until 3 months before admittance or months after the delivery of the child that she noted small masses in both breasts. These tumors gradually increased in size but did not inconvenience her in any way and she was able to nurse the infant up to the time of her entrance into the ward.

Physical examination revealed multiple, somewhat soft and unattached masses in the substance of both mammary glands. The nipples were not retracted and there was no abnormal secretion from them. The overlying skin was not adherent to the underlying masses. The axillary lymph nodes were not enlarged.

The operative procedure consisted in the removal of both glands. Elliptical incisions were made about each breast by blunt dissection both organs were separated from the surrounding structures. The fascia, pectoral muscles and the axillary lymph glands were not removed. Approximation of the wound margins was obtained with ease by silk worm gut sutures.

After operation her course was free from any complications except for a rise in temperature of 1 to 2 degrees the first few days. The wounds healed nicely with no discharge of milk from the lines of incision.

After she left the hospital however her course was progressively downhill. She was seen by Dr. McNealy on numerous occasions following the bilateral mastectomy. At these times he noted all the clinical manifestations of metastases to the lungs. The patient died 3 months after the operation.



Fig 2 Varying sized and shaped cells containing granules and lobules of fat. The loose reticular stroma with relatively few cells represents the less compact portion of one of the largest masses seen in Figure 1. Sudan 111 stain. X 300.

**Macroscopic description (Fig 1).** Both glands were covered with coarsely wrinkled skin and presented 8 to 10 varying sized nodular elevations that were from 1 to 2 centimeters above the normal cutaneous surface. The nipples were not retracted nor was there any dimpling of the skin over the masses. Surfaces made by cutting revealed 10 round or ovoid bodies up to 3 by 4 by 6 centimeters in the left gland and 15 similar masses in the right. Three fourths of the right and one fourth of the left breast were replaced by these tumors. They were located at various depths but none were adherent to the overlying skin. All were well circumscribed from the surrounding mammary tissues by a whitish gray and firm structure that formed a membrane which varied from 1 to 2 millimeters in thickness. The nodes were composed of gray white moderately firm material that was irregularly mottled, pale yellowish white. The cut surfaces of these portions were covered with a glairy whitish gray syrupy and tenacious mucoid substance. In the central portion of one of the larger nodes in the left breast there was a deep reddish purple and irregular area which measured 1 by 1.5 centimeters in diameter. The small amount of relatively normal appearing glandular substance was composed of pale yellow material through which interspersed irregularly were grayish white streaks and bands of firm tissue that varied from 0.5 to 1 millimeters in thickness.

**Microscopic examination** of sections taken from the whitish gray masses and the mammary substance revealed the circumscribed masses to be composed of areas varying in cellularity and the amount of intercellular substance with in the same tumor mass leaving no vestige of mammary structure to be identified. The cells varied considerably in size in that their diameter ranged from 10 to 25 microns. In the regions where the intercellular stroma was most abundant the cells were usually round or ovoid in shape but there were also elongated cells of spindle shape which were most abundant however in the most cellular portions. A well defined membrane surrounded the cyto-



Fig 3. Shows two mitotic figures in one of the smaller nodes. Hematoxylin and eosin stain  $\times 500$

plasmic and nuclear substance. In the cytoplasmic portions were varying quantities of neutral fats which in some cells appeared as minute granules that were surrounded by acidophilic homogeneous material. Many of the cells particularly in the portions where the stroma was less abundant contained huge drops of fatty material with the nucleus of the cell located in the periphery. These huge intracellular accumulations of fat stained a uniform orange with Sudan 112 but in other cells the large mass was composed of small accumulations of fat that were enclosed by a moderately distinct outer membrane. The spindle shaped cells also contained varying sized minute similarly staining bodies (Fig 2). The nuclei usually corresponded to the shape and size of the cell, were rich in chromatin and were surrounded by a well defined membrane. A distinct nucleolus with abundant chromatin occupied most frequently the central area of the nucleus. In the cells in which there was none or a very small amount of fat in the cytoplasm were frequently found very small well defined nucleoli like bodies. These minute ocyphlic structures were located in the nuclear portions and varied from two to six in number. Most of these bodies were scattered singly in the nucleus but occasionally some were grouped just within the nuclear membrane but none was found in the cytoplasm. In many of the cells that contained no fat in the protoplasm the nucleus appeared slightly vacuolated and in many the Sudan 112 had stained small round and ovoid areas a very pale orange color. Although mitosis was not at undant various stages of nuclear division were seen (Fig 3). The amount of intercellular material varied in inverse proportion to the cellularity of the masses. In the areas between the cells that were rich in fat many granules and globules of neutral fat were to be observed with a small amount of very delicate fibrillar connective tissue and occasional small groups of lymphocytes. An occasional capillary was seen coursing through the stroma. In the areas where the cells were less numerous the fine connective tissue formed a meshwork in which there was a very finely granular substance that stained pale purplish blue with hematin.

The mammary substance (Fig 4) was separated from the tumor masses by a connective tissue membrane which



Fig 4. A small amount of tumor tissue adjacent and separated from the actively secreting breast tissue by a well defined layer of connective tissue. Hematoxylin and eosin stain  $\times 28$

nearest the nodes was composed of loosely arranged and interweaving fibrils but adjacent to the mammary structures was more compact. The lobules were made up of numerous varying sized and closely packed alveoli that were lined with large low cuboidal cells. Many of the alveolar spaces were empty but others contained a finely granular acidophilic material with varying sized lipid granules lipophages and a few lymphocytes. These products were also present in the lactiferous and interlobular ducts. The gray white bands seen in the gross specimen were composed of dense connective tissue from which radiated similar but thinner septa that separated the glandular lobules. The capillary plexuses, venules and lymphatics about the active alveoli showed no abnormalities.

The tumor in this case fulfills the usual criteria upon which the diagnosis of liposarcoma is based but its general behavior is somewhat different. The degree of malignancy is more marked than usual for within the course of 3 months both mammary glands were involved. Although the neoplasms were well encapsulated and movable, metastases were present and resulted in the patient's death within 7 months after the first observation of the nodules in the breast. The rapid course can, to a certain extent, be explained by the increased vascularity and glandular activity of the organ during lactation, for it is generally accepted as in carcinoma, that then there is a greater degree of malignancy. The emptying of the alveoli and ducts by the suckling of the infant undoubtedly had some effect upon the stroma in which the tumor cells were located, thus favoring their growth, extension, and dissemination.

Clinically, considerable difficulty in making a diagnosis is encountered. The usual tumors and tumor like lesions of the breast in association with lactation were considered in the differential diagnosis. Chronic abscesses were out of the question in that there was no previous or present evidence of a localized inflammatory process or any so called caking of the breast. Galactoceles are usually not so numerous and upon pressure there was no milk expressible from the nipple. Multiple cysts are not so firm and they usually transmit light. Lactation hypertrophy of numerous mammary adenomata was seriously considered, pre-operatively.

The question arises as to the origin of the fat located in the cells of the tumor. Fatty degeneration can hardly be considered for the cells have the properties of young fat cells. In addition, the presence of mitotic figures in regions that are not associated with any inflammatory changes indicates that one is confronted with cells that are rapidly growing and not in a state of degeneration. Against fatty infiltration although the breast is an organ rich in fat and there is a hypercholesteræmia during lactation is the fact that the intercellular areas where the cells contained the largest amount of fat were poor in this substance. Also the fibroblast is not possessed with even moderate phagocytic power. So little fat is present in these areas that it could easily be derived from the lipoblasts which have undergone disintegration. The presence of the extranuclear granules and fat globules corroborates to a certain extent, the statement made by Jordan and Kindred that fat globules are formed within the cells coalesce, and appear as large fat bodies in the cytoplasm.

#### SUMMARY AND CONCLUSIONS

1. An unusual case of a liposarcoma is reported. The tumor was located in the mammary gland and occurred during the period of lactation in a woman 41 years of age.

2. The neoplasm is unusually malignant in a lactating breast, both locally and by means of metastases.

3. Additional evidence is submitted to the theory that the embryonic fat cell is derived from the undifferentiated mesenchymal cell.

4. Malignant tumors of the breast occurring during lactation are usually very difficult to diagnose and radical surgical treatment must be instituted early to obtain satisfactory results.

5. Although a considerable amount of the mammary gland was replaced by the tumors, the function of secreting milk was still maintained.

6. Sarcoma of the mammary gland occurs in 2 to 3 per cent of all tumors of the breast but in no instance has there been any case of liposarcoma of the breast which could be found in the literature.

#### BIBLIOGRAPHY

1. BARSIE and MOLLARD. Lyon méd. 1926 cxxviii 633.
2. CALDWELL and ZINNINGER. Surg. Gynec. & Obst. 1923, xl, 4, 6.
3. COMELLE. Arch. f. path. Anat. 1911 cccxv 68.
4. EWING. Neoplastic Diseases, 3d ed. p. 195. Philadelphia and London W. B. Saunders Company 1918.
5. HARBITZ. Centralbl. f. allg. Path. u. path. Anat. 1912 xliii 868.
6. JACOBSON. J. Cancer Research. 1921 vi 109.
7. JAFFÉ. Arch. Path. & Lab. Med. 1926 i 381.
8. JORDAN and KINDRED. Textbook of Embryology, 1st ed. p. 46. New York: Appleton 1926.
9. KEIBEL and MALL. Human Embryology. Vol. 1. p. 392. 1910.
10. MABELLINO. Berl. klin. Wchnschr. 1881 xviii 13.
11. MCCONNELL. J. Med. Research. 1908 xix 223.
12. RAZOR. Frankfurt. Ztschr. f. Path. 1913 xiv 359.
13. ROBERTSON. J. Med. Research. 1916-17, xxiv 131.
14. SAIZER. Wien. klin. Wchnschr. 1888 i 199.
15. SCHILLER. Surg. Gynec. & Obst. 218 1918.
16. SCHWABE. Wien. med. Wchnschr. 1921, lxxvii 806.
17. SENTILEEN. Arch. f. path. Anat. 18, 8 vi 330.
18. SPRINGER. Zentralbl. f. Gynaek. 1928 lii 806.
19. STANZE. Inaugural dissertations. München 1902.
20. STICH. Berl. klin. Wchnschr. 18, 1 x 606.
21. TERRIER. Bull. et mém. Soc. de chir. 1890 xvi 34.
22. WALDEYER. Arch. f. path. Anat. 18, 3 xi 336.
23. WELLS and HIRSCH. Am. J. M. Sc. 1920 clix 356.

## SACROCOCCYGEAL TERATOMATA WITH MALIGNANT DEGENERATION IN CHILDHOOD

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**T**ERATOLOGY embodies wide ranges of thought and commands a tremendous amount of space in medical literature. It is especially fertile in the various theories of causation and the variety of morphological structures and combinations observed. We shall limit our discussion to the teratomata of sacrococcygeal type that have undergone malignant degeneration in infancy and childhood.

## REPORT OF CASE

O.S. (872) a white male child 2 years and 11 months of age was admitted to the Post Graduate Hospital on September 27, 1938. The familial and past histories were entirely negative. The child weighed 6 pounds 4 ounces at birth and the labor was normal.

The chief complaint was that 2 months prior to admission to the hospital two hard lumps about the size of walnuts were noted in the right gluteal region. A few days prior to this the child fell a distance of three steps landing in a sitting position.

Two weeks later i.e. 6 weeks prior to admission the parents noticed the stools to be ribbon shaped on defecation or as they termed it shaped like tooth paste coming from a tube. At this time the child when at stool would lean toward the left due to the progressively enlarging masses in the right buttocks. These symptoms persisted until admission to the hospital. The child's general condition was good. The head, neck and thorax including the heart and lungs were essentially negative. The abdomen was slightly distended. The liver could be felt dipping down a breadth of a finger and a half below the right costal margin. The entire abdomen on palpation gave a doughy feel. There was a sensation of shotty nodular masses in both lower quadrants. In each inguinal region a large stony hard movable gland about 2 centimeters in diameter could be felt. The genitalia were negative.

In the right gluteal region there was a noticeable protuberance making the buttocks asymmetrical and practically obliterating the right gluteal fold. The skin over this region was tense but not adherent to the deeper structures. Beginning at the level of the anus was a hard infiltrated mass about the size of a large orange. It was slightly movable and not tender or fluctuant. At the upper left portion of this mass there were superimposed two smaller masses almond sized and shaped and they were hard and moved freely over the surface of the deeper lying larger mass. The masses did not move in synchrony with motion of the right thigh. About 5 centimeters above the anus was a small hole leading in toward the pine. The anus admitted the examining finger easily but almost immediately there was encountered a hard mass on the right side encroaching markedly on the rectum pushing this viscus to the left subsequently leaving very little lumen. The mass was smooth and there was no pain on examination nor was there any rectal bleeding following it. All of the deep reflexes were present and hyperactive except the right Achilles which was absent. No pathological reflexes were elicited. A tentative diagnosis of a teratoma that had undergone malignant degeneration was made.

On the first hospital day the blood count was: red blood cells 4,330,000; hemoglobin 78 per cent; white blood cells 10,000 with 53 per cent polymorphonuclear leucocytes and 47 per cent lymphocytes. The urine was negative. The stool showed a large amount of blood on chemical examination. The Wassermann test was negative.

On the third hospital day an X-ray examination of the chest for possible metastases was negative. A roentgenogram of the lumbar spine revealed what may be a developmental defect in the last sacral segment and a sacrococcygeal area with a tumefaction of the soft structures over and below this area suggesting the likelihood of a spina bifida.

On the fourth hospital day the mass in the right gluteal region had grown to twice the size on admission and where as heretofore the examining finger on rectal examination had been easily admitted it now was admitted with difficulty. The rapid growth combined with a slight rise in temperature (100 degrees) and a leucocyte count of 13,000 with 7 per cent polymorphonuclear leucocytes and 28 per cent lymphocytes made some of the attending physicians temporarily at least consider the possibility of an abscess.

On the sixth hospital day Dr. Stewart aspirated the sinus opening in the midline just above the anus and obtained no pus or fluid. He did a biopsy on the inguinal glands on both sides the subsequent pathological diagnosis of which was metastatic papillary adenocarcinoma.

*Pathological report by Dr. Ward H. Cook:* Gross: Five irregular ragged soft hemorrhagic portions of lymph nodes replaced by tumor tissue mucinous and necrotic in character measuring respectively 25 by 20 by 13 millimeters 20 by 13 by 12 millimeters 19 by 16 by 10 millimeters 14 by 14 by 12 millimeters and 15 by 14 by 6 millimeters. On section they are very friable soft and hemorrhagic. Microscopic: The lymph node is entirely destroyed by an extraordinarily vascular infiltrating new growth composed of epithelial like cells arranged for the most part in the form of irregular branching papillae. Occasionally the cells are columnar in form and produce gland like tubules. Mitotic figures are focally frequent. Sections from the skin show a communicating sinus lined with granulation tissue infiltrated with various forms of wandering cells including foreign body giant cells. Sections from this region show no involvement by the tumor growth. Diagnosis: Papillary adenocarcinoma metastatic. Note judging from the clinical history it is possible that the primary tumor will show multiple cell differentiation and prove to be essentially a teratoma.

In view of the diagnosis and the fact that the mass was becoming larger and encroaching more and more on the rectum thus making obstruction subsequently inevitable Dr. Stewart performed a colostomy on the thirteenth hospital day.

On the fifteenth hospital day a transfusion of 400 cubic centimeters of whole blood was given by the Unger method. The patient received routine care and in addition was placed in a tub of warm water for 10 minutes daily at the time the colostomy dressing was changed. The gluteal mass remained approximately the same size.

On the twenty third hospital day X-ray therapy to the abdomen and gluteal region was instituted subsequent treatments being given on the twenty fourth and twenty fifth hospital days.



Fig. 1 Photograph of patient

On the twenty-fourth hospital day the white blood count was 12,750 with 77 per cent polymorphonuclear leucocytes and 23 per cent lymphocytes while on the following day it was 3,000 with 71 per cent polymorphonuclear leucocytes and 9 per cent lymphocytes showing plainly the effects of the roentgen therapy. The patient spent the better portion of each morning on the roof getting the benefit of the sun's rays through a Vita glass solarium. Following the X-ray therapy the gluteal mass became progressively smaller until on the thirty-fourth hospital day the examining finger on performing a rectal examination could again be introduced without difficulty.

On the forty-first hospital day and subsequently there was marked abdominal distention.

On the forty-second hospital day the blood count was red blood cells 1,000,000 white blood cells 7,600 of which 74 per cent were polymorphonuclear leucocytes and 26 per cent lymphocytes with one eosinophile. The hæmoglobin was 70 per cent and the blood calcium 12.1.

On the forty-sixth hospital day on abdominal examination, a mass could be felt in the right lower abdominal quadrant following the ascending colon. It was superficial and apparently about the size of an orange. The abdomen was markedly distended and presented on its surface a network of engorged veins. The gluteal mass had so diminished in size that on rectal examination it was barely discernible. A blood count revealed 9,500 white blood cells of which 67 per cent were polymorphonuclear leucocytes and 33 per cent lymphocytes. The hæmoglobin was 8.7 (Newcomer). From this time on the child became progressively weaker the abdomen at the same time becoming more distended. He complained of diffuse abdominal pain.

On the sixtieth hospital day an X-ray film taken of the chest for possible metastases was negative.

On the sixty-first hospital day a stool examination revealed a large amount of blood. From this time on the stools varied in color from a brown to a frank black.

On the sixty-seventh hospital day the red blood cell count was 450,000 with a hæmoglobin of 40 per cent. The child became progressively more emaciated and weaker and on the seventy-fourth hospital day a transfusion of 300 cubic centimeters of whole blood was given by the Unger method. Tenderness and enlargement of the abdomen in contradistinction to the marked emaciation of the other parts of the body became more pronounced. Large quantities of blood were lost in the stool and the abdominal veins became more engorged.

On the ninetieth hospital day the child began vomiting parts or all of each feeding this persisting until death.

On the ninety-fifth hospital day the blood count was red blood cells 3,750,000 white blood cells 1,400 of which 70 per cent were polymorphonuclear leucocytes and 30 per cent lymphocytes and the hæmoglobin was 60 per cent. The child became progressively weaker and died on the one hundred and eighth hospital day at the age of 3 years and 3 months.

**Autopsy report.** Gross autopsy findings. Body: that of an extremely emaciated white male child 3½ years of centimeters long slightly icteric. Pupils are regular equal and markedly dilated 7.5 millimeters in diameter. The superficial lymph nodes—supraclavicular axillary and inguinal—are palpable about the size of a split pea. There are old venipuncture marks in both cubital fossae. The abdomen is markedly protuberant. On the lower thorax and upper abdomen are several dilated superficial venules. Slightly above and parallel to each Poupart's ligament is a fine linear scar right 2.5 centimeters long left 4 centimeters. In left lower quadrant is an old patent colostomy with two openings the whole measuring 5 by 3 by 2 centimeters. Posteriorly at the level of the first lumbar vertebral spinous process is a right paramedian shallow diverticulum ulcer 9 millimeters in its widest diameter. In the intergluteal fold 3.5 centimeters from the anus a linear scar 1.5 centimeters long at the superior end of which is a noticeable dimpling. Both lower extremities up to the crest of the ilium show marked pitting edema. The scrotum is likewise moderately edematous there is a small right hydrocele.

The primary incision extended from the suprasternal notch to the symphysis pubis. The panniculus adiposus over chest is represented by a very thin edematous grayish tissue with few small fatty lobules in it. The dome of the diaphragm reaches the third rib on the right the fourth on the left.

No free fluid is found in the chest. The inferoposterior portion of right lower lobe is dark red and somewhat edematous. No gross areas of consolidation are observed. The posterior inferior edge of the lobe contains a grayish firm very cellular metastatic nodule 2 by 1 by 1 centimeters. There are five other smaller injected nodules scattered here and there in the lobe subpleurally. Another large nodule 1.2 by 1 by 0.5 centimeters is present in the anterior inferior edge of the left lower lobe and is surrounded by a thin zone of hemorrhage. The pericardial sac contains a little clear straw-colored fluid. The heart measures 5 by 4 by 3 centimeters. The foramen ovale is patent. No other abnormalities are found.

The abdomen contains about 100 cubic centimeters of sanguinolent fluid non-floccy but the visceral and parietal peritoneum is smooth and glossy. The internal inguinal rings are closed. The gastro-intestinal tract shows nothing remarkable grossly except that the colostomy opening has been made 12 centimeters from the anal sphincter. The appendix is grossly normal 3 by 0.4 centimeters. The liver 4½ by 10 by 20 centimeters and weighing 140 grams occupies most of the abdominal cavity extending 12 centimeters below the costal border in the right anterior axillary line 9 centimeters in midline and 4 centimeters in the left anterior axillary line. Its surface is roughly nodular due to numerous single and conglomerate very cellular planar nodules of tumor tissue gray yellowish or green in color with or without small specks of hemorrhages into their substance. The largest single nodule measures 2.5 centimeters in diameter. The surrounding compressed liver parenchyma is either dark red yellow or green in color so that the whole organ presents a variegated intermixture of colors. The gall bladder is small being filled with about 3 cubic centimeters of clear amber bile. The bile ducts are patent. The spleen 8.5 by 3 by 2.5 centimeters weighing 40 grams is

grayish purple in color and soft. The trabeculae are prominent. The malpighian bodies are not evident. The left kidney is wholly absent. The right kidney, 9 by 5.5 by 4 centimeters, shows well defined fetal lobulations after the capsule has been stripped easily. On section the renal pelvis contains much irregular sandy crumbly sediment. Its mucosa is but slightly injected. The ureter is not dilated although the ureteral opening into the bladder is occluded by a small grayish calculus. The left corresponding opening is absent. Between the sacrococcygeal bones and the rectum and strongly adherent to both is a yellowish very fibrous mass 3.5 by 5 by 3 centimeters containing several pea sized discrete gray nodules of tumor tissue. The rectal wall and mucosa are not involved by this growth. There is no thrombosis of the iliac vessels. The mesenteric and retroperitoneal lymph nodes are soft gray and measure not more than 7 millimeters in their long diameters.

Anatomical diagnosis: sacrococcygeal carcinomatous teratoma with metastases to liver, lungs and inguinal nodes. Aplasia of left kidney. Status post-colostomy.

**Microscopic findings.** Thymus: little lymphoid tissue is seen. The Hassall's bodies are large. There is marked fibrosis. The muscle heart fibers are uniform in size. There is distinct striation everywhere. Sections of the lung show some bronchi with hemorrhage and exfoliated epithelium. Most of the air spaces are air containing. Some of the lung sections show an irregular epithelial growth that shows glandular structure everywhere. The cells in the stained preparation are partly dark and small. Others are rather pale and large. There is also a great variety in the nuclei. Some of them are small and dark, others are vesicular. Sections of liver show very marked fatty changes. There are only dark stained trabeculae along the periportal spaces. Liver cells are large, pale and foamy. Irregular areas of liver tissue are replaced by epithelial growth which is glandular in arrangement. The cells are cuboidal and have large vesicular nuclei. There are very numerous mitotic figures. Sections of the kidney show well preserved structure. The epithelial cells of the tubules are somewhat swollen. There are no glomerular changes seen. Sections of small intestine show congestion of the submucous vessels. Section of the sacrococcygeal tumor shows a great variety of tissues. These are derived apparently from all three germ layers. There is striated muscle as well as cartilaginous tissue, also a great deal of embryonic fatty tissue where the pale fat cells have almost central nuclei. There are also irregular areas with large pale cells with vesicular nuclei and small nucleoli. These are evidently nerve cells. Most of the section is taken up by a malignant epithelial growth very undifferentiated. The origin of these cells is obscure as they do not resemble any mature cells. They are cuboidal, dark stained and show numerous mitotic figures. The glandular arrangement is everywhere well preserved.

Autopsy diagnosis: sacrococcygeal carcinomatous teratoma with metastases to liver, lung and inguinal nodes. Aplasia of left kidney. Status post-colostomy.

Teratomata are not uncommon and may occur anywhere in the body, the sacrococcygeal and anorectal regions being the most frequent sites (6). For a discussion as to etiology and experimental study on the subject the reader is referred to Bosaeus's excellent paper.

That teratomata of the sacrococcygeal and anorectal regions show a tendency to undergo malignant changes and that when this occurs in children the phenomena are fulminating is con-

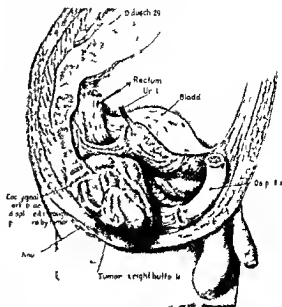


Fig. Drawing showing pathological condition found at autopsy.

ceded by the profession. This is borne out by Gant who says that 'teratomata of the sacrococcygeal and rectal regions show a tendency to undergo cancerous degeneration unless evacuated or removed early', as well as MacCallum (7) who writes: 'It is of interest here as an example of the contributory causes of tumor growth to recall the fact that malignant tumors frequently develop from one tissue of a teratomatous growth and metastasize alone, although in the absence of this specific change such teratomata are benign'. This of course is true. However, our search of the literature gives a different impression, as only 4 cases of sacrococcygeal teratoma which had undergone malignant degeneration in childhood were reported and only two of those were pathologically above reproach. In the two others the pathologists were satisfied in saying that the tissue suggested carcinoma. These cases will be described in detail in the end of this article.

The chief complaint is usually that of a tumor seen or felt, or of constipation, the latter varying from the simple type of that in which the patient infrequently passes ribbon like stools due to the distortion of the rectal lumen from encroachment of the neoplasm as in our case. Occasionally the mass may be situated in such a manner or be of such a size as to present the syndrome of intestinal obstruction as was the case in Sawday's report and which would have been inevitable in our case had a colostomy not been done.



The degree of symptomatology is widely variable (Gant) as the tumor may be single or multiple small or large, unilocular or multilocular, it may have thick or thin capsule, be located extra rectally, in the bowel, upon the surface of the sacrum or coccyx or between the anus and sacral tip, may be round, lobulated or pedunculated, or exist as sinuses or as simple dermoid cysts situated posteriorly in the median line or sacrococcygeal crease.

If these tumors be considered as congenital anomalies as most authors do consider them, an accompanying anomaly should be searched for and ruled out. Our case had an accompanying spina bifida. The importance of finding a secondary congenital anomaly accompanying an obvious one is made clear by De Sanctis and Craig.

The treatment is radical surgery, the tumor being removed *en masse* whenever possible. If there be metastases palliative treatments by X ray or radium are used and complications such as intestinal obstruction are treated by palliative measures as they present themselves.

The prognosis when malignancy has ensued is practically fatal but if every teratoma is considered a potential malignancy with a fatal outlook and removed whenever possible prophylactically the sparse number of these pitiful cases will be still further reduced.

The other pathologically undisputed cases of malignant teratomata (sacrocoecygeal) in children were the first of 2 cases reported by Fletcher and Waring and one reported by Pandali, Forsyth and Stewart.

Fletcher and Waring's case was a boy 2 years of age in whom a tumor about 3 inches in diameter was found on the left side by rectal examination. It projected and pushed the rectum forward. The growth together with the rectum was removed. The child was re-admitted in 2 months with extensive intrapelvic recurrence and enlarged lumbar and inguinal nodes. The child died 3½ months after operation. The mass was partly solid and partly cystic and lay immediately under the skin, which was not involved. The soft solid portion was found to be adenocarcinoma, the recurrence in the nodes having the same structure.

The case of Pandali, Forsyth and Stewart (8) was almost similar pathologically. The patient was a 12 months male infant. The chief complaints were retention of urine which could not be relieved by a catheter and difficulty in defecation. On rectal examination half an inch above the anus, a lobulated swelling about one inch in diameter, could be felt posteriorly. It pushed the rectum forward. After enucleation of this mass,

the child died and no autopsy was obtainable. Referring to the pathological examination of the mass they go on to say that microscopically the bulk of the tissue is of two kinds corresponding in the main to the two varieties seen by the naked eye. The firm portions, in which small cysts lie are teratomatous. The soft friable parts of the cyst wall are composed of intracystic papillary adenocarcinomatous tissue, showing all stages of transition from the aforementioned simple villous papillomata to frankly malignant tissue.

The two other cases were as follows. A "sacro-teratoma" described by Leopold and Phillips from a stillborn child had a complex structure. It was 5 1/2 by 2 1/2 inches and contained bone cartilage, fat muscle, fibrous tissue, lung digestive tract, retinal pigment, and glandular tissue. One area suggested carcinomatous change.

Sawday's case was a boy 4 years and 5 months of age showing partial intestinal obstruction due to a post rectal teratoma. As in our case, on rectal examination the pelvis was found to be filled with a hard mass lying behind and somewhat to the left of the rectum. An exploratory laparotomy showed a retroperitoneal mass. Biopsy showed a remarkable new growth consisting of a mass of tissue which, on close inspection, was seen to be made up of small papillary outgrowths of fibrous stroma covered with epithelium of an elementary type. It is practically certain that this is part of a teratoma. What the tissue is it is impossible to say. It is too slightly differentiated to have a special function or name. This may be the main element of its malignancy which is evidently of a high order. If the entire aberrant mass could be examined, there is little doubt that other tissues would be discovered though in the case of a malignant overgrowth of teratomatous tissue it is quite usual for one type to become considerably more increased than the remainder. The child died 17 days later and on autopsy the tumor showed various tissues including muscular, nervous, and epithelial cells all in a primitive state of development. There was cartilage and a calcified area in the section. He proceeds to say. It would appear to be a matter of doubt whether this tumor was highly malignant or benign. Some of the sections suggest the former but several cases have been described in which similar tumors have eluded discovery until fairly late in life.

#### SUMMARY AND CONCLUSIONS

1. A case of malignant degeneration of a sacrococcygeal teratoma occurring in childhood is here reported.

2 This phenomenon is not so common as is generally thought or else the cases are not reported in the literature as they should be

3 Every sacrococcygeal teratoma in childhood should be considered a potential malignancy and prophylactically excised whenever possible

# BIBLIOGRAPHY

- 1 BOSAEUS W. Genese d Ovarialembryome Akad Abhandl Uppsala 1926
- DE SANCTIS A G and CRAIG J D Duodenal stenosis and atresia Am J Dis Child 19 9 xxxvii 826
- 3 FLETCHER H M and WARING H J Two cases of congenital sacro-coccygeal tumour Tr Path Soc Lond, 1900 p 226

- 4 CANT S G Diseases of the Rectum and Colon Vol II, p 263 Philadelphia W B Saunders Company 1923
- 5 LEOPOLD SAMUEL and PHILLIPS L B Sacrococcygeal teratoma New York M J, 1906 p 479 September
- 6 MACCALLUM W G A Textbook of Pathology 4th ed p 1000 Philadelphia W B Saunders Company 1928
- 7 Ibid p 1123
- 8 PANDALIA K G FORSYTH W L and STEWART M J Sacrococcygeal teratoma containing gliomatous (?), chordomatous and ependymal carcinomatous tissue J Path & Bacteriol 1924 xxvii 139
- 9 SAWDAN, A L Partial intestinal obstruction in child due to post rectal teratoma Brit M J 1925 ii 635

## THE BIFURCATION OPERATION

### INDICATIONS, TECHNIQUE, AND RESULTS

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IN 1919 Lorenz published an operative procedure on the hip to which he applied the descriptive term 'bifurcation'. In this operation the upper end of the femur is converted by osteotomy into a two pronged fork. The medial prong of this fork rests against the acetabular area of the pelvis, and serves as a new weight bearing head. The lateral prong of the fork contains the trochanteric portion of the femur and serves as a muscle lever through which the extremity is eventually activated.

This procedure was first recommended for use in irreducible congenital dislocations of the hip, and also in cases of ununited fracture of the neck of the femur. Upon first glance the operation seems grossly irrational and unanatomical and it has been quite generally condemned upon these grounds. However, the striking results of the procedure have gradually been breaking down this once uncompromising opposition, and it is now being more widely accepted as an outstanding contribution to the surgery of the hip joint.

Since the operation was first proposed, there has been a gradual widening of the indications for its employment, and we now recognize its value in a wide variety of conditions affecting the hip.

The operation is, upon close analysis neither illogical nor unanatomical, but is based upon solid anatomical and surgical considerations. Used in conditions in which there is a disorganization of the hip joint the operation aims to create a stable, mobile and painless joint not by attempting a plastic duplication of a normal joint, but by constructing a neo arthrosis, which will support the body upon a solid unbroken femoral shaft in such a manner as to exclude the pathological area from weight bearing.

The logic of the operation can best be appreciated by considering the indications for its use and the manner in which the bifurcation achieves results in each case. Briefly stated, the operation is indicated in conditions in which there is instability of the hip joint by virtue of irreducible dislocation, ununited fracture or a disorganizing or inflammatory process. In all of the conditions which will be specifically mentioned below the outstanding indication for the operation is pain.

The indications can be considered under three headings: (1) dislocations of the hip; traumatic

congenital, or pathological, (2) ununited fractures of the neck of the femur and allied conditions and (3) inflammatory processes involving the hip joint.

**I Dislocations of the hip.** Under the first heading (Fig. 1) we must include irreducible congenital dislocations of the hip, pathological dislocations of the hip and irreducible traumatic dislocations. In all of these cases the mechanical insufficiency of the hip is based upon similar anatomical conditions. The body is deprived of direct support through a total absence of contact between the pelvis and the femur. The body is slung upon the psoitrochanteric muscles and the stretched capsular and ligamentous structures of the hip. By reason of the absence of unbroken osseous support the patient exhibits telescoping movement of the femoral shaft and the Trendelenburg sign, that is sagging of the pelvic basin upon bearing weight on the pathological hip. The musculoligamentous sling which bears the thrust of the body weight becomes stretched and fatigued and eventually a train of painful manifestations develop which complete the incapacitation of the patient.

In all such conditions the bifurcation relieves the mechanical factors which cause the disability. The shaft of the femur is osteotomized in an oblique direction at the level of the acetabulum and the upper, pointed end of the distal fragment is thrust into the acetabulum invaginating before it the capsular structures which intervene. The trochanteric fragment of the femur unites with the shaft and constitutes the second prong of the fork which completes neo arthrosis. The body weight is supported on the unbroken femoral shaft. The capsule which intervenes between the upper end of the shaft and the acetabulum, prevents a union between pelvis and femur and insures motion. The muscles attached to the greater and lesser trochanters remain attached to the same structures, and through them the shaft is activated. Thus the body has gained support at its normal point of support the acetabulum telescoping movement of the femur cannot occur the muscles and ligaments are relieved of the strain of supporting the body weight the Trendelenburg sign disappears and painless motion and locomotion are secured.

2 *Ununited fractures of the neck of the femur and allied conditions* Under this heading, the bifurcation is applied to conditions in which there is a disturbance of the mechanical integrity of the hip, due to a severance of the continuity of the neck of the femur (Fig 2) In addition to fractures of the neck, such conditions as complete epiphyseolysis and coxa vara luxans are included In the latter condition, the coxa vara is of such an extreme degree that under weight bearing a virtual subluxation of the hip occurs

In these patients too the thrust of the body weight falls upon the musculoligamentous structures surrounding the hip, and eventually pain, which in many cases completely incapacitates the patient, results In common with the dislocations, these patients exhibit telescoping movements of the femur and the Trendelenburg sign though to a lesser extent They differ from those of the first group, in that the acetabulum is occupied by the head of the femur instead of being empty

The operation in such conditions aims to exclude the pathological cervical area from weight bearing and to re-establish an unbroken support for the body at the normal area of support, the acetabulum The femur is severed obliquely at the level of the lower margin of the head, and the two pronged conformation is established, the medial prong resting directly under what may well be termed the chin of the head Here too the capsular structures of the joint intervene between the upper end of the shaft and the acetabular structures (Fig 2) The trochanteric prong becomes the activating muscle lever, and the body weight is supported at the acetabulum by an unbroken shaft of the femur Motion is insured by virtue of capsular interposition, and all the telescoping movement of the femur is overcome The pathological neck is, as it were, shunted out of function, and painless motion, locomotion, and weight bearing are secured

3 *Inflammatory processes involving the hip joint* Here we have a wide, and it must be said a growing group of indications for the bifurcation Perhaps in this category these indications are not quite so clear cut and each case must be considered from all aspects In general we can say that the bifurcation can be recommended in painful conditions of an inflammatory nature, in which an exclusion of the pathological joint from weight bearing is deemed advisable In addition to these cases, are those with inflammatory conditions which endanger the stability of the hip joint by disorganizing its constituent parts The inflammatory conditions which have been considered in special cases as being subject to

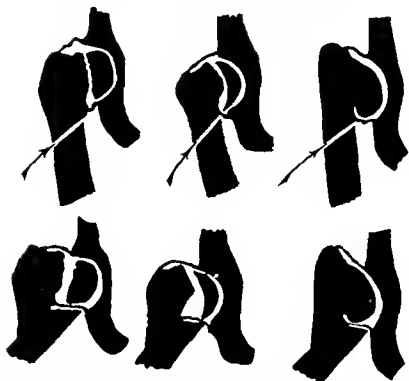


Fig 1 The bifurcation as applied to congenital traumatic or pathological dislocations of the hip and to all other cases in which the acetabulum is empty It will be noted that the osteotomy is entirely extracapsular and that after displacement the capsule intervenes between the upper end of the distal fragment and the acetabulum The arrows indicate the level and the line of osteotomy in each case 1 represents the osteotomy as modified by Hass

anchorage by means of the bifurcation are (Fig 3) (a) arthritis deformans, (b) tuberculosis of the hip and (c) Charcot's disease of the hip

In all of these cases the object of the operation is to relieve the pathological area from function, and to re-establish support through the femoral shaft by means of the bifurcation It must be emphasized that under no circumstances should the method be used in cases in which there is ankylosis of the hip as in such cases motion will not be re-established

The design of the bifurcation must be modified to some extent in cases coming under group 3 The purpose of the operation is altered somewhat, as the instability and painful manifestations in these patients result from intra articular pathology, and therefore, to relieve the pain, the articular area itself must be relieved from weight bearing In the cases previously considered (groups 1 and 2), the upper end of the lower fragment is dislocated directly into the articular area



*Fig. Diagrams illustrating the use of the bifurcation as applied to cases falling in group 2, i.e. ununited fractures of the neck of the femur and allied conditions. Note that in all of these cases the upper end of the lower fragment is displaced directly under the chin of the femoral head and that the capsule intervenes between the upper end of the distal fragment and the head. The arrows indicate the level and the line of osteotomy in each case.*

In cases with intra articular pathology, such a procedure would fail to achieve results, as the pathological area would continue to bear weight and therefore continue to cause pain. If the displacement in these cases is made not into the acetabular area but rather just below the rim of the acetabulum on the body of the ischium then the joint area is shunted out of its weight bearing function and the stresses falling through the neoarthrosis are painlessly borne. This changed displacement is illustrated in Figure 3.

In cases of *arthritis deformans* pain is to be considered the outstanding indication for the operation. By transferring the weight bearing function from the pathological head to the neoarthrosis produced by the operation we can definitely alleviate the pain, while we can preserve to a large extent the motion of the hip.

In tuberculosis of the hip the operation may be considered in those cases in which there is wandering of the acetabulum with destruction of the acetabular capital area. In these cases, as explained above, the aim is to lodge the upper end

of the distal fragment directly under the rim of the acetabulum. It is still a question among those who have had experience with the operation as to whether early intervention in a tuberculous hip might by throwing the pathological area out of function cause a recession of the disease.

In cases of Charcot hip the operation can be used with considerable circumspection. Here too the hip is stabilized by means of the bifurcation although the question will always arise as to the possibility of the failure of union between the trochanteric fragment and the shaft. If this union should fail the operation will be a failure from the standpoint of both stability and function.

#### THE OPERATION

The site of election for the osteotomy is determined from the X ray picture the distance being measured from the tip of the great trochanter and it is well to bend a flexible probe to indicate both the level and the direction of osteotomy to serve as a guide at the time of operation.



Fig 3 The bifurcation as applied to cases of inflammation involving the hip joint. In these cases the upper end of the lower fragment is displaced against the lower acetabular margin so that the pathological acetabular region receives none of the thrust. The arrows indicate the level and direction of osteotomy in each case.

The patient is placed on the sound side with the pathological hip slightly flexed, and a loosely packed sand bag is placed between the thighs. An incision is made from a point 1 inch above the tip of the great trochanter downward over the lateral aspect of the femur for a distance of 6 inches. The fascia lata is incised along this line and the muscles are divided bluntly in the line of their fibers, thus exposing the femur. Lane retractors are placed under the femur thus elevating it in the wound and protecting the deeper structures from injury. The site of osteotomy is determined by means of the previously sterilized bent probe, and at the site of election a smooth oblique osteotomy of the femur is performed. The line of this osteotomy should run upward and inward toward the acetabulum and should divide the femur so that most of the lesser trochanter remains with the upper fragment. This is important because in the bifurcated hip the trochanteric fragment serves as a muscle lever and should contain the attachment of the iliopsoas muscle. After the femur has been divided the osteotome is held in place and the lower fragment is abducted by the

assistant or preferably by the operator, because this is the most important step of the operation. Upon abduction the divided extremity of the shaft slides along the osteotome blade, and dislocates inward toward the acetabulum. The osteotome is then removed, and the position of the pointed extremity of the shaft is verified and improved by digital inspection. The thigh is brought into 40 degrees of abduction and 10 degrees of flexion. This will bring the cut surface of the trochanteric fragment in apposition with the lateral aspect of the shaft of the femur. It has been the recent practice of the writer, due to one case from the service of Dr. Leo Mayer, in which union failed to occur between the two fragments, to roughen the outer surface of the upper end of the distal fragment by means of an osteotome, so that chips of bone are raised from this portion of the shaft which comes in contact with the cut surface of the upper fragment. This provides a better stimulus for osteogenesis and favors more certain and firmer union while adding no new technical difficulty to the operation. The wound is closed in layers. There is no necessity for suturing or

nailing the two fragments together, as union between these parts takes place *without* this

The thigh is placed in a plaster spica bandage reaching from the ribs to the toes. The thigh should be in full 40 degrees of abduction, 10 degrees of flexion, and slight external rotation.

In cases in which the acetabulum is fairly well formed and is not occupied by the head, that is in cases of congenital and pathological dislocation of the hip, Hass of Vienna, modifies the line of osteotomy. His line of division in these cases is performed with the apex at the level of the acetabulum and the line of osteotomy extending from this level in the coronal plane downward and posteriorly. Upon abduction the cut surfaces of the two fragments remain in apposition and an angulation is formed which is placed in the acetabulum, and which functions as the weight bearing head (Fig. 5). This method is perhaps somewhat more difficult to consummate and has as its principle advantage a saving of a few centimeters in the length of the extremity. It also gives a somewhat smoother weight bearing head as an end result. It is perhaps best in most cases, however, to adhere to the original line of oblique osteotomy in the sagittal plane.

#### AFTER-CARE

The patient may be permitted out of bed in the full cast in 3 weeks and allowed to walk with crutches. At the end of 6 to 8 weeks the spica is shortened to the knee and weight bearing with crutches is continued. At the end of 3 months the cast is removed, and massage and exercises, particularly of the abductors of the thigh are given.

#### RESULTS

The bifurcation operation in properly selected cases yields surprisingly good functional and cosmetic results, although it should never be recommended purely upon a cosmetic indication as a certain amount of shortening always results. The operation is designed primarily for the purpose of re-establishing painless function. After due time has been allowed for proper after treatment we can expect that the extremity will function painlessly and that the mechanical capacity of the hip joint for weight bearing will be re-established. The motions of the bifurcated hip are for the most part surprisingly free. Flexion of the hip can frequently be accomplished past a right angle from full extension. Abduction can be expected to approximately 40 degrees. Rotation of the hip, however, is almost absolutely restricted. The shortening which ensues as a result of the operation is not as great as might be ex-

pected and is considerably masked by the abducted position of the hip. It will be evident from studying the diagrams and X rays presented with this article that the upper level of the lower fragment is displaced in most cases almost horizontally inward, and that the upward displacement is in most cases very slight. The actual additional shortening amounts to considerably less than an inch. Most of the hips which are bifurcated are in some degree of adduction contraction prior to operation with a resultant apparent shortening due to this deformity. The establishment of an abducted position of the thigh will create an apparent lengthening of the extremity which will mask to a very considerable extent the moderate additional actual shortening produced by the bifurcation.

The gait of the patient following operation is for the most part very satisfactory. The pelvis on account of the abducted and shortened extremity is moderately tilted toward the pathological side but this can be overcome to a large extent by a concealed raise in the shoe. Since the body has regained a solid bony support, the Trendelenburg sign disappears. Progression up and down stairs is frequently possible in normal manner. In the more or less rare cases in which a bilateral bifurcation is performed, if care be taken to make the osteotomy at precisely symmetrical points, an excellent cosmetic result can be predicted.

The results in cases of elderly people with ununited fractures of the neck of the femur are surprisingly gratifying. The operative shock is negligible, the patient can, if necessary, be placed in an upright position out of bed on an improvised stool made from a motorcycle saddle if hypostatic pneumonia is feared. At the end of 6 to 8 weeks, when the cast is shortened to the knee these elderly patients can be up and about on crutches. With proper handling the mortality in such cases even in advanced years is surprisingly low.

#### COMPLICATIONS

There are very few untoward incidents which are likely to result from the bifurcation. As has been mentioned before very little shock is to be expected. The loss of blood is minimal, and post-operative pain is rarely a serious complaint.

There is one complication which can easily be avoided. The upper, pointed extremity of the femoral shaft in most instances comes to rest directly beneath the femoral vessels in the acetabular region. This fragment of the femur if displaced anteriorly may impinge upon or even conceivably perforate these vessels. Even a moderate impingement may seriously compromise

the circulation in the extremity. For this reason the operator must be sure not to displace this fragment anteriorly. This is avoided by flexing the thigh while it is being abducted, and placing the thigh in at least 10 to 15 degrees of flexion in the final plaster bandage. This will insure the integrity of the vascular supply of the extremity.

A second complication, which is perhaps more difficult to avoid, is that of non union between the shaft and the trochanteric fragment of the divided femur. This is an extremely rare occurrence, but at least one case has been called to my attention in which it has occurred. Non union in these cases is synonymous with failure as the femoral shaft then lacks the necessary muscular attachments to insure useful motion and the stability of the displaced upper end of the shaft is extremely insecure. Non union can be best avoided by insuring good apposition between the trochanteric fragment and the shaft, and also by maintaining the primary plaster bandage intact for fully 6 to 8 weeks before shortening to the knee. In cases in which the cast is shortened too soon, there is danger that the thigh with the entire lower fragment will rotate externally, completely dissolving contact between trochanter and shaft. If non union should occur, it is perhaps wisest to attempt to secure union by exposing the trochanteric area, and pegging or screwing the trochanter to the lateral aspect of the shaft after both surfaces are freshened.

#### CASE REPORTS

**CASE 1:** Miss M. H. aged 59 years was admitted to the Lenox Hill Hospital on the orthopedic service of Dr. Charles H. Jaeger on April 4, 1925 with the diagnosis of ununited fracture of the neck of the femur. The patient had fractured her femur a year prior to admission and had been treated in various New York hospitals including an orthopedic institution. She was suffering from incessant pain day and night upon admission and walked only with the greatest difficulty. She was emaciated and her general physical condition was poor. On April 13 in conjunction with Dr. Jaeger a bifurcation was performed upon the fractured extremity. The upper extremity of the shaft was displaced directly below the head of the femur. There was no postoperative shock and but little pain in fact this patient was almost immediately relieved from the intense pain which she had been enduring since her injury. Three weeks after the operation this patient walking with the aid of crutches was demonstrated before the Orthopedic Section of the New York Academy of Medicine. The cast was shortened to the knee at the end of the sixth week and removed 3 months after operation. She was discharged from the hospital on July 26 walking with the aid of a cane. The final X ray pictures showed that in the spica the patient had had a considerable amount of abduction which had been established at operation and in consequence there was some impairment of the expected motion in the bifurcated hip. Upon last examination the patient walked with a moderate limp with the pelvis tilted toward the pathological side but she used no crutch or cane. The hip

was absolutely painless and had been so since operation. Only about 10 degrees of flexion and 10 degrees of abduction were possible. This limitation of motion being to a considerable extent due to the failure to maintain the full abducted position of the lower fragment in the spica. Progression up and down stairs was possible one step at a time. In spite of the deficient motion the patient is highly pleased with the result.

**CASE 2:** M. S. school girl aged 10 years was admitted to the Hospital for Joint Diseases, on the service of Dr. Finkelstein on September 21, 1925 with the diagnosis of chronic infectious arthritis of the right hip. The disability started when patient was 3 years old at which time she had severe pain in the hip joint. She was treated in the Hospital for Joint Diseases. A suppurative process was present in the hip which was drained and the child was placed in traction and subsequently permitted to walk in a caliper brace. At the time of the present admission the child walked with a marked right hip limp with extreme lordosis. There was a flexion contraction of the right hip of approximately 30 degrees. The motions of the hip were painless and free except for the flexion contraction. There was a shortening of  $\frac{3}{4}$  inches of the right lower extremity and marked atrophy. The X ray examination showed destruction of the head and neck of the right femur with upward displacement of the trochanter. The child was first treated for the flexion contraction of the right hip. On September 24, 1925 a Soutter fasciotomy was performed on the right hip, and the flexion deformity was corrected. The child was subsequently placed in traction and the shortening of the extremity was reduced as far as possible. On April 1, 1926 a bifurcation operation was performed on the right hip and the extremity was put up in a plaster spica bandage in 40 degrees of abduction and 10 degrees of flexion. The spica was removed and the position was verified on May 13 and at this time a short spica, extending to the knee was applied and the patient was permitted to walk with crutches. The spica was removed at the end of the third month and the child was given the usual massage and abduction exercises. At no time during the postoperative treatment was there any considerable degree of pain or discomfort. When last seen approximately 1 year and 8 months after operation the child had recovered almost full functional use of the extremity. Approximately 1 inch of shortening was present. The calves on both sides measured the same. Flexion of the thigh was free to 90 degrees abduction to 30 degrees rotation was limited. The child walked with the pelvis tilted somewhat toward the right side but stood without exaggerated lordosis and walked up and down stairs with normal progression. There has been no pain in the hip since operation.

**CASE 3:** Mrs. R. A. housewife aged 46 years was admitted to the Hospital for Joint Diseases May 7, 1926 with the diagnosis of marginal subluxation of the left hip. The patient had limped since birth and for the past 18 years had had pain in the left hip which was rapidly getting worse. The patient was unable to walk without the aid of a cane. Physical examination revealed extreme limitation of motions in all directions in the left hip. This was due to painful muscle spasm. The X ray film showed a marginal subluxation of the head of the left femur. On May 13, 1926 a bifurcation was performed on the left hip. Dr. I. S. Tunick assisting. The line of osteotomy was calculated so that the upper tip of the distal fragment was on the level with the lowermost margin of the head of the femur. The femoral shaft was displaced inward so that its proximal extremity rested in the lower portion of the acetabulum. A spica was applied with the hip in about 15 degrees of flexion 40 degrees of abduction. Postoperative course was uneventful. It was necessary to replace the original spica



on May 7 due to a failure of the original plaster to set. The usual bifurcation after treatment was used. The spica was shortened to the knee at the end of the sixth week. The patient was discharged from the hospital walking with crutches in a short plaster spica on July 7. There was no pain on weight bearing at this time. After final removal of the spica this patient disappeared from observation and received absolutely no after care. Approximately 9 months later she appeared in the dispensary of the hospital walking without a cane or a crutch with a scarcely perceptible limp and reported that she had been absolutely free from pain since her discharge. At the time of the last examination approximately 18 months after operation the patient showed an almost normal range of motion in the left hip except for a limitation of rotation. There was a shortening of approximately three fourths of an inch of the left lower extremity. The patient walked unusually well and progression up and down stairs was consummated normally. This patient it might be remarked was extremely overweight a condition which greatly added to the difficulties of carrying out the procedure.

CASE 4 Mrs. A. M. housewife aged 34 years was admitted to the Hospital for Joint Diseases on the service of Dr. Finkelstein on October 4, 1926 with the diagnosis of ununited fracture of the neck of the left femur. The patient sustained her injury 4 years prior to admission by falling on the ice. She received treatment at her home for 6 weeks followed by 6 weeks of chiropractic treatment. A year later she entered a New York hospital where an attempt was made to secure union by closed reduction and traction without result. Upon admission there was a shortening of 1 1/2 inches of the left lower extremity with elevation of the left great trochanter. Motions of the left hip were restricted in all directions, particularly in reference to abduction. The patient walked with a decided left hip limp with use of crutches.

Upon admission to the hospital the patient's physical condition was not good. An abdominal tumor mass was present in the right lumbar region. This mass was diagnosed as polycystic kidney. In spite of her physical condition a bifurcation was determined upon after a preliminary period of traction to reduce the shortening and was performed with the assistance of Dr. I. S. Tunick under nitrous oxide gas-oxygen ether anesthesia on November 4, 1926. The postoperative course was uneventful; no opiates or sedatives were necessary. The patient was permitted to bear weight in the full cast with crutches 3 weeks and 2 days after the operation. Six weeks after operation the spica was removed and a short plaster spica extending to the knee was applied. The patient was discharged on December 23, 1926 approximately 7 weeks after operation and massage and exercises were instituted. At the last examination made approximately 1 year after discharge she walked without a cane or a crutch with a very slight tilt of the pelvis toward the left and with very little limp. Progression up and down stairs was normal. The thigh could be actively and passively flexed to 90 degrees. Rotation was limited. The actual measurable shortening of the left lower extremity was 1 inch. The patient has been free from pain since discharge from the hospital.

CASE 5 Miss S. female aged 3 1/2 years was referred to orthopedic service of Dr. Charles H. Jaeger at the Lenox Hill Hospital by Dr. Dewitt Stetten on March 11, 1927 with the diagnosis of pathological luxation of the left hip. The patient had been treated in the Lenox Hill Hospital for suppurative arthritis of the left hip from April 26, 1925 to September 13, 1925. The suppurative process involved the head and neck of the femur and eventually caused absorption of the entire area with a formation of a broomstick femur and a shortening of the extremity amounting

in seven eighths of an inch. Subsequent to her discharge from the hospital after her initial illness she was treated in the orthopedic dispensary of the hospital by means of a traction caliper brace in order to overcome the excessive shortening of the extremity. On March 29, 1927 with the assistance of Dr. Jaeger a bifurcation was performed. The osteotomy was made at the level of the acetabulum which was empty as there had been complete absorption of the head and neck. Postoperative convalescence was uneventful. On May 13 the child was discharged in a short plaster spica in which she was permitted to walk. The plaster was totally removed at the end of the tenth week. When last seen the child walked with a moderate left hip limp which was well concealed by the clothing. There was a shortening of approximately three fourths of an inch. The X-ray films of this case show a tendency of the prong of the femur in the acetabulum to absorb. It is too early to consider this a final result in this particular case although the present function is excellent.

CASE 6 Miss F. B. aged about 20 years, diagnosis tuberculois of the right hip. This patient from the service of Dr. Leo Mayer, Hospital for Joint Diseases, came to the hospital 6 years ago. She was treated by orthopedic surgeons by means of a plaster of Paris spica for 6 weeks by a long hip brace for 18 months and after that a convalescent brace for 2 years. The brace was then left off altogether. Immediately prior to her first visit she had been in Florida where she had been taking the sun cure. She felt well and had no pain in the hip but had some pain in the region of the knee. Her parents reported that she had limped quite markedly during the year prior to her first visit.

Examination revealed a well developed girl, looking husky and strong. There was no evidence of any general tuberculosis. The patient walked with a marked limp due to instability of the right hip. Shortening of 1 1/2 inches was present in the right hip abduction was possible to 15 degrees and there was diminished power in the abductor muscles. The X-ray picture showed marked absorption of the head of the femur with an upward excursion of the great trochanter which was close to the pelvic wall.

There was considerable discussion in regard to this case. The Whitman reconstruction operation was recommended by a number of consultants but a bifurcation operation was finally decided upon. This was performed on April 10, 1927 at the Hospital for Joint Diseases by Dr. Leo Mayer assisted by the writer. An oblique osteotomy of the shaft was done after the upper end of the femur was exposed through a 6 inch incision. The osteotomy was performed obliquely beginning 3 1/2 inches below the tip of the greater trochanter and extending upward and inward to a point just below the trochanter minor. The leg was abducted and the distal fragment dislocated so that the apex of the cut surface rested against the inferior surface of the acetabulum. The extremity was put up in a plaster spica in 40 degrees abduction and 10 degrees of flexion. The patient had a short period of abdominal pain after the operation. She was permitted to be out of bed in the spica on May 14 and the spica was removed at the end of May. There was some swelling of the right leg at this time. The patient was able to abduct the right leg with only slight force. She walked quite nicely with the use of crutches. Following her discharge she made rapid progress, learning to walk with a very slight limp and without exhibiting the Trendelenburg sign.

On March 1, 1928 she walked practically without limp. The actual length of the left leg was 30 inches, of the right leg 27 inches. Despite this shortening the apparent length of the extremities owing to the pelvic tilt was equal. The motions of the right hip showed flexion free to 90 degrees, extension to 180 degrees, abduction to 45 degrees, adduction



Fig. 4 (left) Case 2 Pre-operative roentgenogram Destructive arthritis of hip after infantile epiphysitis. This hip exhibited no stability and should be classed as a pathological dislocation of the hip

Fig. 5 Case 2 Postoperative in plaster. The outlines have been accentuated to demonstrate more clearly the two pronged fork of the bifurcation. Note that the upper end of the distal fragment enters the acetabulum. This is destined to serve as the weight bearing head of the femur

to the neutral position. There was about half of the normal rotation present.

CASE 7 Mrs L. O. aged 49 years. This patient from the service of Dr. Leo Mayer developed tabes dorsalis 3 or 4 years previously. About 2 1/2 months prior to admission she felt a sudden pain and slipping in her right hip. She was treated with traction and a plaster-of Paris spica after which treatment she could walk fairly well but had pain.

Examination showed marked crepitations within the right hip joint. The extremity was swollen throughout and externally rotated. The patient was unable to bear her weight upon the right leg. X ray examination of the right hip showed a degenerative process within the joint with dislocation of the right hip and remnants of the head of the femur within the acetabulum. A diagnosis of Charcot hip was made.



Fig. 7 Case 2 The patient lying with the left thigh hyperflexed in order to fix the pelvis is able fully to extend the bifurcated (right) thigh



Fig. 8 Case 2 The patient lying with the left thigh hyperflexed in order to fix the pelvis is able to flex the bifurcated (right) thigh to approximately a right angle



Fig. 6 Case 2 Approximately 3 years after operation. This X ray indicates the end result of the bifurcation. It will be noted that the pointed weight bearing prong has been rounded off so that it forms a serviceable head. The joint space of this neo arthrosis is clearly visualized. This hip is stable and mobile.

A bifurcation operation was done by Dr. Leo Mayer at the Hospital for Joint Diseases on September 16, 1927. An oblique osteotomy of the femur was performed. The femur



Fig. 9 Case 2 Photograph of the patient standing and balancing upon the right extremity which has been operated upon by bifurcation



Fig. 10 (left) Case 4. Fracture of the neck of the left femur before operation. The outline of the trochanter has been retouched.

Fig. 11. Case 4. Retouched X ray showing the end result of a bifurcation performed for an ununited fracture of the neck of the femur. Note that the head lies between the two prongs of the fork. The sharp short prong is the weight bearing portion and the trochanteric fragment is the muscle lever.

being sectioned in a line running medially and upward into the lesser trochanter of the femur. The lower fragment was dislocated into the acetabulum and a plaster of Paris spica was applied with the hip in 40 degrees of abduction. The postoperative convalescence was uneventful. The plaster was removed below the knee on October 28 and the patient was able to walk with the assistance of one crutch. The condition continued to improve and by January 1928 she was walking without a crutch or a cane. On February 9 1928 measurements revealed a 2 inch shortening of the right lower extremity. Active abduction was present to 35 degrees active flexion to 25 degrees and passive flexion almost to 90 degrees were present. With a compensation in the right shoe she walked very nicely with only a slight limp.

CASE 8. Mr W. G. aged 52 years was admitted to the Lenox Hill Hospital on January 14 1928 complaining of pain in the right hip and leg which had made it impossible for him to work. The history dated back over 18 years beginning with an attack of sciatica for which he was treated by various measures. The pain continued intermittently and at times was so severe that he was unable to walk and finally he was incapacitated completely. He was referred to the Dispensary of Dr. Walter Bopp.

Examination revealed a well developed elderly white haired man who walked with a right hip lump and with the aid of a cane. The right hip was extremely painful on motion very marked muscle spasm was present. There was no ankylosis. X ray picture revealed an extreme osteo-arthritis of the right hip with some tendency toward subluxation.

The patient was operated on January 17 1928 on the service of Dr. Charles H. Jaeger at the Lenox Hill Hospital. Dr. Jaeger and the writer operated. The line of incision extended obliquely into the lesser trochanter and the displacement of the lower fragment was made at the point immediately below the rim of the acetabulum on the ischium. A spica was applied in 40 degrees of abduction 10 degrees of flexion. The convalescence was uneventful and painless. The patient was permitted out of bed on February 13 on which date he stood upon the bifurcated extremity in the full spica. The spica was shortened to the knee on March 3 1928 and totally removed on April 10 1928. He was discharged on May 10 1928 at which time he walked without pain using a crutch as a cane. The right hip was carried in 10 degrees of abduction. Voluntary abduction was possible to 40 degrees voluntary flexion to 110 degrees and voluntary extension to 180 degrees. Rotation

was almost totally restricted. Measurements from the ante superior spine to the internal malleolus were right 35 1/2 inches, left 34 1/2 inches. The patient was last seen on June 18 1928. Although he was able to walk without a cane he used one and walked without pain. Motions remained approximately as recorded above except that slightly more adduction was possible.

CASE 9. A male aged 33 years was admitted to the Hospital for Joint Diseases on the service of Dr. Harry Finkelstein December 14 1927 with the diagnosis of an ununited fracture of the neck of the left femur. The patient fractured his left hip 6 months prior to admission and was treated in another institution in a plaster of Paris spica without result. The patient complained of severe pain in the left hip completely incapacitating him. The patient upon admission was confined to bed by his disability and was unable to rise without assistance. The left lower extremity was in external rotation. Voluntary motion of the hip was very much limited and painful. The passive motions were painful and restricted on this account. Sliding motion of the trochanter was present. Measurements of this case were through some error not recorded. On December 14 1927 a bifurcation operation was performed upon the left hip. The usual spica was applied in 40 degrees of abduction on 10 degrees of flexion. The postoperative convalescence was uneventful. The spica was shortened to the knee on January 20 1928. During the month of February the patient was permitted to walk with crutches in the shortened cast. The spica was completely removed on March 11 1928 and on March 13 he was discharged walking on crutches complaining of slight pain in the affected extremity. When last seen in the follow up clinic in June 1928 he was walking with the use of a cane and was still complaining of pain in the hip. About three-fourths of an inch of measurable shortening was present. Motions of the hip were remarkably free and painless. Flexion was present to 90 degrees abduction to 40 degrees adduction was movable and could be consumed only to 10 degrees of abduction. No sliding motion of the femur was detectable. It is too early to state the final result in this case. The outlook however is very favorable.

CASE 10. A male aged 33 years was admitted to the Hospital for Joint Diseases service of Dr. Harry Finkelstein on October 19 1927 with the diagnosis of ununited fracture of the neck of the femur. Fourteen weeks prior to admission he tripped and fell on the street injuring his right hip. He was taken to a hospital where he was treated and discharged limping and having considerable pain. On



Fig. 12 (left) Case 4. The weight bearing function of the bifurcated hip is well shown in this illustration. The absence of the Trendelenburg sign is particularly noteworthy. Photographed 18 months after operation.

Fig. 13 Case 4. Active useful flexion of the bifurcated thigh. The scar of the operation is visible over the trochanteric area. Photographed 18 months after operation.

admission he presented the aspect of a somewhat aged man who walked with a severe right hip limp. The motions of his hip were limited and painful. Flexion was possible through an arc of 40 degrees abduction and rotation were strictly limited. One inch of shortening was present in the right lower extremity. The patient was first treated in an abduction internal rotation spica without result. On December 22, 1927, a bifurcation operation was performed by Dr. Harold Luskin. The osteotomy was performed below the lesser trochanter and displacement was made against the inferior acetabular margin. The cast was shortened to the knee on February 16, after which the patient was able to walk with the aid of a crutch. The cast was removed on March 23, 1928, at which time the patient was able to walk without support. When last seen in June 1928, the patient walked without crutch or cane and with out pain. The motions of the hip were painless and relatively free, considering the proximity of the operation. Flexion was possible through an arc of 90 degrees. The abducted position of the extremity was still fairly fixed. The patient is showing rapid improvement in all respects.

#### SUMMARY AND CONCLUSIONS

In conclusion, there are several points which might be reiterated. The bifurcation must not be regarded in any sense as a direct attempt to reconstruct the hip anatomically. The operation was primarily designed to relieve the pain resulting from a wide variety of conditions affecting the hip joint. It secures a functional and reasonably

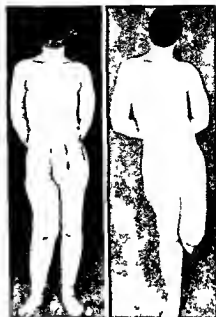


Fig. 14 (left) Case 6. End result in a case of tuberculous destruction of the articular area. The photograph was taken 21 months after operation. Note the pelvic tilt due to shortening and abduction of the extremity. When the patient is fully dressed this is masked to a very great extent.

Fig. 15 Case 6. This photograph illustrates the absence of the Trendelenburg sign when the patient stands upon the bifurcated extremity. This will perhaps give some idea of the stability and functional capacity of the new formed articulation.

satisfactory cosmetic result, by the creation of an extra articular neo arthrosis. Anatomically, the new joint bears but little external resemblance to a normal hip joint. Architecturally and mechanically, the newly created articulation is sound and of sufficient strength to transmit the normal stresses falling through the hip. The operation, therefore, must not be condemned because upon first glance it is unanatomical. Any critique of the procedure should be based upon a thorough comprehension of the mechanical and physiological principles involved.

A word of caution is not out of place. Although relatively simple in its details, the operator can easily go astray. It is absolutely necessary care fully to plan the line of osteotomy prior to the operation and accurately to osteotomize the femur in the calculated line. A variation of an inch or even less in the location of the section of the femur, or a variation of a few degrees in the direction of the section may mean failure.

Even after the osteotomy it is necessary to exercise the utmost care in correctly displacing

and accurately maintaining the desired position of the thigh until the plaster spica is completed. So important is this consideration that it is highly recommended that the operation should be performed in conjunction with a co operator, who should be responsible for the proper displacement of the cut femur, while the operator firmly holds the osteotome blade in place after the bone has been completely divided. This small detail materially adds in securing a proper position. After displacement the proper holding of the fragments is of paramount importance, and can best be trusted to one thoroughly familiar with the principles of the operation. A failure in proper holding will lead to an unsatisfactory result.

It is important to remember that union between the shaft and the trochanteric fragment is essential to a satisfactory end result. In personal communications from Lorenz and some of his co workers, the writer has been informed that non union has been observed in but one case of a total of 115 bifurcations performed in Vienna up to 1926. More recent figures from this clinic are not at present available. Several cases of non union have been reported to me by some of my colleagues. The reason for failure of union lies most probably in a failure to maintain proper position and apposition during the application of the spica. I have also noted that some operators are inclined to shorten the spica too early. This permits external rotation of the lower fragment and loss of proper apposition. Dr Harry Finkelstein has suggested the use of a nail to anchor the two fragments in place. The use of an osteoporeostical

graft may also be considered for this purpose. In the writer's experience these procedures have not been found to be essential, but may perhaps add to the security of position and the mental comfort of the operator.

The bifurcation is an operation still in its developmental period. Except in the Vienna clinic of Lorenz and his co workers, the operation has been adopted very slowly. The results over a long period of years still remain to be determined, but from personal observation abroad and from fairly extensive use in this country, the writer would strongly urge an open minded trial of what would appear to be one of the most valuable operative procedures for the re-establishment of the hip joint.

The writer wishes to express his thanks to Dr Charles H. Jaeger of the Lenox Hill Hospital to Dr Leo Mayer Dr Harry Finkelstein and Dr Isidore Tunick of the Hospital for Joint Diseases and to Professor Adolf Lorenz and his co workers in Vienna for their kind co-operation in forwarding this work.

#### REFERENCES

1. ERLACHER PHILIPP J. Die Technik des orthopaedischen Eingriffs. Vienna Julius Springer 1924.
2. HASS J. Neue Anwendungsgebiete der Lorenz'schen Bifurcation. Zentralbl f Chir 1927 No 13.
3. Idem. Palliativ-operative Behandlung der Arthritis deformans der Huelfte. Zentralbl f Chir 1927 No 47.
4. LORENZ. Ueber die Behandlung der irreponiblen angeborenen Huelfluxationen und der Schenkelhals pseudarthrosen mittels Gabelung. Wien klin Wchnschr 1919 No 41.
5. Idem. Die sogenannte angeborene Huelfverrenkung. p 270. Stuttgart 1920.

## AN EXTENSION FRAME FOR THE REDUCTION OF FRACTURE OF THE VERTEBRAL BODY

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THE urgent need of a simple, effective, and safe means of obtaining hyperextension of the spine became manifest in the course of a study of compression fracture of the vertebra conducted during the past 3 years on the fracture service of the Massachusetts General Hospital. The apparatus described here has been devised to meet this need. Its use is recommended in this as well as in other conditions requiring spinal extension.

In the treatment of compression fracture of the vertebra, correction of the deformity of the crushed body is necessary to assure restoration of function of the back.

Uncorrected, the wedge shaped vertebra throws the dorsal spine into the forward bent position. The effort to maintain the erect position enforces in turn, a deep lumbar lordosis.

This exaggeration of spinal attitude, made necessary by the deformity of vertebrae is possible only through the sustained action of muscles and ligaments. If the lordosis be extreme muscles tire, and mild activities become laborious. Strain follows, causing backache, unless frequent rest is possible. The result from the economic standpoint is disability.

Analysis of the large number of poor end results in these compression fractures discloses that the cause of disability is backache of muscle and ligament origin far more often than of pain at the site of fracture or pain referred along the corresponding peripheral nerve segments. Local pain at the site of fracture, and sometimes referred pain may be eliminated by spinal fusion but spinal fusion without correction of deformity may not be relied upon to relieve muscle strain the commonest cause of disability in these cases.

Correction of the deformity of the vertebral body is accomplished by extension of the spine beyond the point at which the anterior ligaments and the discs come under tension. Until the spinal joints above and below are locked in complete hyperextension, correction of the vertebra cannot take place since forces employed up to that point are consumed in physiological extension. Beyond this point correction begins and should then be continued until the upper and lower surfaces of the involved vertebra are restored to normal relationship. Failure to correct deformity by extension is due to the fact that

it is not carried beyond the limit of extensibility of the spinal joints above and below the fracture.

The accompanying roentgenograms show the correction obtained in three types of vertebral body injuries. In these and all cases treated on this service in the manner described herewith either very slight and passing cord symptoms following the injury were found or no cord symptoms whatever were shown.

Figure 1 shows the correction obtained by gradual hyperextension over a period of 10 days. In this case, one of fracture dislocation of the first and second lumbar vertebrae, correction was brought about by means of the Bradford frame which was bent from day to day, the extension being increased until the physiological limit had been passed. This method is cumbersome and difficult to control in adults.

Figure 2 shows the correction obtained in a crush fracture of the second lumbar vertebra by the apparatus described here. Gradual extension was carried on over a period of 14 days.

Figure 3 shows the correction in a crush fracture of the twelfth dorsal vertebra by the same means accomplished in 5 days.

## DESCRIPTION OF APPARATUS

The apparatus is essentially a Bradford frame, excepting that spring steel bands, broad side horizontal are used instead of pipe or tubing. The bands can be bent to render the frame concave or convex, but will not bend toward one another. The best quality (chrome vanadium) spring steel is advised, preferably  $3/16$  inch by  $1\frac{1}{4}$  inch.

Canvas is stretched tightly across this frame and upon it the patient lies in the dorsal position. As the frame is rendered more and more convex, the spine is extended.

When such a frame is placed across a fixed yoke or cross bar and the ends are lowered, it gradually becomes more and more convex just as the flexible board of a child's see saw bends over the saw horse when it is balanced with weight at each end.

The same effect is created by fixing the frame at each end and raising the cross bar or yoke by some form of jack.

Frame A (figs 4, 5, and 6) represents the extension frame attached to the bed. In this frame, the yoke is stationary and the ends of the

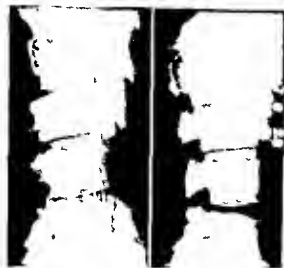


Fig 1 Fracture dislocation first and second lumbar vertebrae (very slight and passing cord compression symptoms) before and after correction by hyperextension frame



Fig 2 Compression fracture second lumbar vertebra (no cord compression symptoms) before and after correction by hyperextension frame

frame are raised or lowered through window cord and pulleys attached to the Balkan frame. This apparatus is the most generally adaptable form since it may be adjusted to the usual hospital beds is portable and is cheap.

The yoke is clamped to the bed at a point opposite the lesion. The frame previously covered with canvas is clamped to the yoke. In this form the yoke is 24 inches above the bed. The frame is about 74 inches long and 24 inches wide.

The heaviest canvas or duck should be used to prevent sagging which will hinder accuracy

of control. The canvas or duck can be stretched tightly across the frame by the use of leather cinch straps, rings and buckles placed about 1/2 inches apart, opposite the spine and 6 inches apart below the buttocks. A separate canvas band about 6 inches wide is placed opposite the buttocks for convenience in nursing and obviates shifting the patient. Made as described the cost is about thirty five dollars and the work can be done by any good mechanic.

*Frame B* (Fig 7) represents the extension frame fixed at its ends to the hospital bed and rendered concave or convex by raising or lowering the yoke by means of jacks.

Slotted bars one at each end are suspended from the end rungs of the bed. Through the slots the spring steel side bands of the frame are passed. The yoke is operated by pinion wheels meshing with the pinion uprights which are attached to the yoke at either end. The pinion wheels are operated by a common shaft turned with a crank handle as illustrated. The mechanism is locked by a ratchet and pawl. In order to obviate accidental release of the pawl a wing screw is attached directly above it. The yoke and jacks may be placed at any desired level of the spine and there fixed to the sides of the bed. This apparatus is very simple to operate. The cost is about twice that of Frame A and it must be made up to fit the type of bed used.

*Frame C* (Figs 8, 9 and 10) represents the extension frame attached to a steel tubing carriage as a separate unit. An additional pair of jacks,

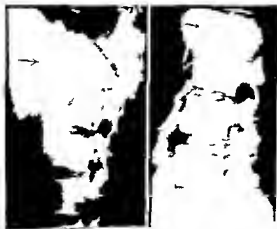


Fig 3 Compression fracture twelfth dorsal vertebra (no cord compression symptoms) before and after correction by hyperextension frame

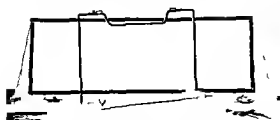


Fig. 4. Frame A. Group of parts showing flexible frame of spring steel bands with window cord attached stationary yoke adjustable to fit various beds. Pulleys through which window cord passes for varying the convexity of the frame. Note clamps at top of yoke to fix to it the flexible frame.

although not necessary, may be placed at the head end to raise this end as the convexity is increased. It obviates a feature disagreeable to some patients of having their heads lower than their bodies. Provision is made for traction should circumstances require its use. This frame costs about twice as much as Frame B.

#### MECHANISM

The correcting force operating through the agency of this frame is that of gravity. It is diffused along the entire length of the vertebral column, is very great, and is completely under control. Each spinal segment falls into proper alignment without strain. There is no force concentration at any one point so that any possible risk is obviated. At the same time, the patient is conscious of no other restraint or discomfort.

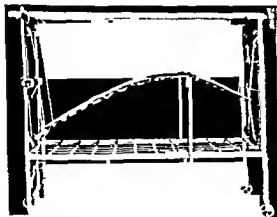


Fig. 6. Frame A. Same as Figure 5 except that the ends have been gradually lowered rendering the frame convex. The yoke is extended in this way. This is the simplest, cheapest form of extension frame described here. It fits the usual hospital bed and is easily made.

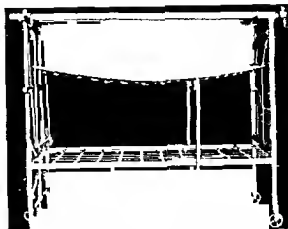


Fig. 5. Frame A. Extension frame covered with canvas attached to bed. The ends are elevated to render it concave. The pulleys are fastened to a Balkan frame.

than having to lie on the back, provided the extension be accomplished gradually.

#### TREATMENT

Treatment should be started with the frame concave, and during the first several days extension should be slow. Thereafter, the rate may be increased and usually after the third or fourth day can go forward rapidly. Full correction is obtained in 5 to 10 days as a rule.

A feeling of tension on the abdominal muscles experienced by the patient heralds the approach of the limit of extensibility of the spine. Hyper-

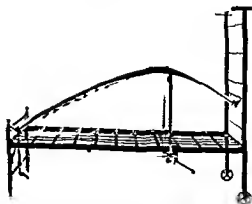


Fig. 7. Frame B. The flexible frame fixed at its ends to the bed is operated by raising or lowering the yoke with jacks. This apparatus must be made to fit the type of bed to be used. More convenient and accurate than Frame A but about three times as expensive.





Fig. 1. Fracture dislocation first and second lumbar vertebrae (very slight and passing cord compression symptoms) before and after correction by hyperextension frame.



Fig. 2. Compression fracture second lumbar vertebra (no cord compression symptoms) before and after correction by hyperextension frame.

frame are raised or lowered through window cord and pulleys attached to the Italian frame. This apparatus is the most generally adaptable form since it may be adjusted to the usual hospital bed; is portable and is cheap.

The voke is clamped to the bed at a point opposite the lesion. The frame previously covered with canvas is clamped to the voke. In this form the voke is 4 inches above the bed. The frame is about 74 inches long and 34 inches wide.

The heaviest canvas or duck should be used to prevent sagging which will hinder accuracy

of control. The canvas or duck can be stretched tightly across the frame by the use of leather cinch straps, rings and buckles placed about 12 inches apart opposite the spine and 6 inches apart below the buttocks. A separate canvas, land about 6 inches wide is placed opposite the buttocks for convenience in nursing and obviates shifting the patient. Made as described, the cost is about thirty five dollars and the work can be done by any good mechanic.

Frame B (Fig. 7) represents the extension frame fixed at its ends to the hospital bed and rendered concave or convex by raising or lowering the voke by means of jacks.

Slotted bars, one at each end, are suspended from the end rungs of the bed. Through the slots the spring steel side bands of the frame are passed. The voke is operated by pinion wheel meshing with the pinion uprights which are attached to the voke at either end. The pinion wheels are operated by a common shaft turned with a crank handle as illustrated. The mechanism is locked by a ratchet and pawl. In order to obviate accidental release of the pawl a wing screw is attached directly above it. The voke and jacks may be placed at any desired level of the pinion and there fixed to the sides of the bed. This apparatus is very simple to operate. The cost is about twice that of Frame A and it must be made up to fit the type of bed used.

Frame C (Fig. 8, 9 and 10) represents the extension frame attached to a steel tubing carriage as a separate unit. An additional pair of jack-

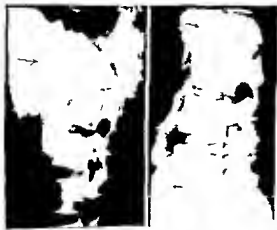


Fig. 3. Compression fracture twelfth dorsal vertebra (no cord compression symptoms) before and after correction by hyperextension frame.

RUPTURED URETHRA OPERATION<sup>1</sup>

(CORF C DAVIS MD, t ACS, CHICAGO)

THE writer wishes to present a method of introducing a catheter from the bladder through the penis in cases of rupture of the urethra. Two sounds are employed which we may designate *A* male and *B* female. Sound *A* is an ordinary sound with a hole drilled through it about one half inch from its tip. Sound *B* (female) is cupped on the tip to receive sound *A* after a suprapubic cystotomy has been performed. Sound *A* (male) is introduced through the meatus of the penis, sound *B* (female) is introduced into the urethra from the bladder. The tips of the sounds in the urethra are then clicked, and the male sound is engaged in the cupped end of the female *B*, sound and then the male sound enters the bladder being

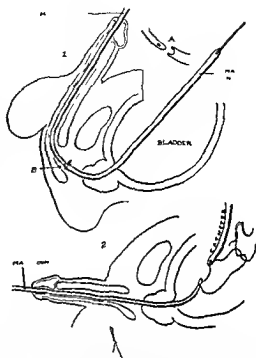


Fig 1. Hole is shown in tip of male sound *A* through which when introduced into bladder a suture is passed. To the suture the tip of a catheter is tied and then brought from bladder through the urethra. This male sound *A* is introduced via meatus of penis. The female cupped sound *B* is introduced into urethra via bladder and guides male sound into bladder after the ends of *A* and *B* have engaged as shown in the small diagram.

Fig 2. *r* Shows male sound introduced via meatus of the penis to site of rupture of the urethra *B* and engaged in the cupped end of the female sound introduced via bladder. *A* demonstrates the cupped end of female sound and tip of male sound with a hole in it. Male sound with a hole through hole at tip is ready to pull the catheter from bladder through penis.

guided by the female sound. A silk or catgut suture is passed through the drilled hole of the male sound in the bladder and a rubber catheter is connected to the suture. The sutures are tied and the catheter is introduced from the bladder through the penis and left in place. The cystostomy, of course, is continued for a number of days for drainage.

The great advantage of this operation is that it does away with the perineal incision which, un-

doubtedly, in many cases causes subsequent strictures. It is a simple method, easily performed, and the end results are gratifying.

On April 20, 1929, the writer used this technique on a patient, A. K., Register No. 2850, I. S. Co. Hospital, Gary, Indiana. The patient had had a severe squeeze between the couplings of railroad cars. A catheter could not be introduced. This technique was employed. The patient made an uneventful recovery.

Read before the Lake County Medical Society, Hammond, Indiana, June 13, 1929.

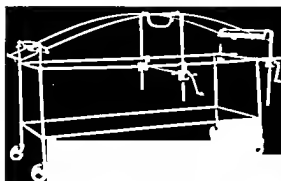


Fig. 9. Frame C. Separate unit. The flexible frame is attached at its ends to a steel tubing carriage and is operated by jacks as in Frame B. The head end may be raised or lowered by the extra pair of jacks. Traction may be used. Very accurate adjustable and convenient. Costs about twice as much to make as Frame B.

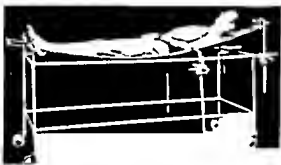


Fig. 9. Frame C. Frame in operation. Spine in slight flexion.

extension is continued until the flatness of the dorsal spine, the flare of the ribs and the absence of abnormal prominence of the spine of the involved vertebra point to correction. At this point lateral roentgenograms have invariably shown the desired correction. Should correction not be complete, extension should then be re-

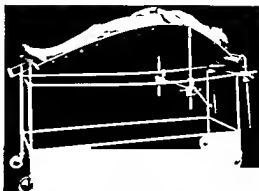


Fig. 10. Frame C. Frame in operation. Spine approaching limit of hyperextension.

sumed until roentgen evidence of restoration of the vertebral contour has been obtained.

The apparatus may be operated safely and according to a prescribed schedule by the usual hospital attendant.

In securing confirmatory roentgenograms the patient is shifted to a Bradford frame narrower than hips and shoulders and bent to the same degree of extension. To this the patient is fixed with swatches and may then be turned on the side for lateral views on the Buckey diaphragm.

Correction having been obtained the patient may be placed on a Bradford frame or provided with plaster shells for a period of 8 weeks. A plaster jacket should then be applied in extreme hyperextension preferably by the aid of Goldthwaite irons and the ambulatory phase of treatment begun. It has been our custom to secure roentgenograms of these patients through windows cut in the sides of the plaster jacket opposite the involved vertebra. Excellent lateral views may be obtained in this way. By doing this before and one week after starting the ambulatory phase a check on the efficiency of the jacket is obtained.

cubic centimeters. A ureteral catheter could not pass the obstruction. Pelvotomy and decapsulation were performed. The patient died a short time after the operation.

The formation of urinary calculi has been attributed to whatever phase of scientific endeavor was at the time popular. In the days of the alchemist, and later, stones were explained on the basis of chemical changes alone. Even today patients are frequently advised to drink only distilled water, it being assumed that processes involved in the formation of renal stones are similar to those involved in the deposition of lime salts on the interior of a hot water boiler. Since distilled water is not readily available, such patients usually drink less than a normal amount of water, so that the urine becomes concentrated and the deposition of urinary salts is enhanced.

Ebstein and Nicolaier, in 1891, for the first time produced stones in the urinary tract of animals by feeding oxamid, a derivative of oxalic acid. Keyser repeated their experiments successfully at The Mayo Clinic but in spite of these promising experiments no one has ever been able to produce urinary calculi experimentally in animals by feeding in excess any of the normal constituents of the animal's food.

Following the work of Pasteur, micro organisms were naturally considered the causative agent of stones. Rosenow and Meisser have reported the formation of stones in the dog's kidney following the production of an artificial focus of infection in a tooth. The part played by focal infection as the cause of renal and ureteral lithiasis is not as yet proved, but Rosenow and Meisser's work strongly indicates it as a factor. In the years 1925, 1926, and 1927, of all the patients with ureteral stones who had special examination of their teeth and tonsils, 82 per cent were found to have definite infection in the tonsillar crypts, in the roots of teeth or in both. The distribution was as follows: infected teeth and tonsils, 34 per cent; infected teeth only, 16 per cent; infected tonsils only, 32 per cent; neither teeth nor tonsils, 18 per cent.

During the last decade the popularity of the diagnosis of stricture of the ureter in explanation for all symptoms led its originator to include the formation of urinary calculi among the ills for which stricture is responsible. In view of the fact that strictures of the ureter are more common in females than in males because of the incidence of pelvic infection to which the former is subjected it is worthy of note that 70 per cent of the patients in this series were males. A further observation that would seem to discredit the part played by the stricture as an etiological factor is the incidence of recurrence in this series. In 32 cases the

stone recurred in the same ureter and in 30 in the opposite ureter.

More recently, as might be expected, vitamin deficiency is being considered as the cause of urinary calculi. This series of cases does not present evidence either for or against this hypothesis.

#### ROENTGENOLOGICAL DATA

The percentage of stones that will not cast a shadow has been variously estimated. Besides the cystine and pure uric acid stones, which fortunately are rare, the recently formed stone, because of its lack of density, is the most difficult to demonstrate roentgenographically and the one therefore most frequently missed. In this series a stone could not be demonstrated roentgenographically in 21 cases (21 per cent). This low percentage of negative results is undoubtedly due to the reading of the plates by the urologist, who has available at the time all the cystoscopic and other data on the case. The roentgenologist, without such aid, cannot be expected to make a definite diagnosis of stone in such a high percentage of cases, for many of the shadows are indistinguishable from phleboliths except for the additional information furnished by the cystoscopic data.

#### CYSTOSCOPIC DATA

Seemingly it would appear that the incidence of a ureteral stone causing obstruction to the passage of the ureteral catheter is high, for the ureter is not large and a small stone would seem sufficient to obstruct a catheter, yet all urologists recall how frequently even large stones fail to obstruct the passage of catheters. In this series, there was definite obstruction in 554 cases. In many cases this was passed easily with a catheter, usually with little, if any, obstruction to the passage of urine.

Grating on the ureteral catheter with transmission of the vibration to the finger tips of the operator was noted in only 192 (19.2 per cent) of the cases and hence cannot be regarded as a particularly valuable test, as absence of the vibration is of no particular significance. The wax tip catheter was used in a few cases and was considered of value only as confirming data.

Inclusion of the shadow of stone by the urographic medium was the chief aid to diagnosis and was the only observation besides the shadow of the stone in 223 cases.

#### TREATMENT

\* Since Lewis, in 1904 first introduced his instruments for the manipulation of ureteral stones, many urologists have persistently endeavored to remove as many ureteral stones as possible by

STONES IN THE URETER<sup>1</sup>

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FROM January 1, 1919 to January 1, 1928, the diagnosis of stone in the ureter was made in 1,001 cases. The results of a clinical study of these cases are recorded herewith.

## SYMPTOMS

Pain originating in the renal area and radiating toward the bladder was noted in 634 cases (63.4 per cent) but only exceptionally did it radiate to the inner side of the thigh or to the genitals. In 37 cases the radiation was reversed; it occurred from the bladder toward the kidney; in these cases the stone was discovered in the lower part of the ureter. Pain in the lower right quadrant without radiation and with little suggestion of renal colic occurred in 138 cases; in such cases the appendix often is removed without relief of symptoms. It was removed in 37 cases in the group of 138, an incidence of 26.8 per cent.

Appendectomy had been performed in 226 of the 1,001 cases; many of the operations without question were indicated but an average of more than 1 in 5 cases of stone in the ureter in which the appendix is absent is probably greater than in any other disease, and the physician must be careful to exclude the possibility of stone if symptoms persist after appendectomy. As further evidence that these figures are not extreme is Cabot's report of 153 cases of stones in the ureter, in 30 of which appendectomy had been performed.

In 162 cases the pain had been entirely epigastric and cholecystitis had been diagnosed. In 17 cases a diagnosis of peptic ulcer had been made elsewhere, and a fluoroscopic examination of the stomach at the clinic proved negative in all but 1 case. Search was made for some other explanation of the epigastric distress and ureteral calculi were discovered the removal of which relieved the symptoms in every case. This frequency of reflex gastric complaint was manifested in 304 cases in which nausea and vomiting occurred during attacks.

During attacks almost half of the patients (456) noted marked frequency and 254 did not have urinary disturbances. Many of the patients gave a history of frequency and slight dysuria associated with vague indefinite abdominal pain with

out a history of colic. This led to the investigation of the urinary tract that resulted in the finding of the calculus in the ureter. The association of vague abdominal pain with urinary frequency would, therefore, seem to be a sufficient indication for a careful roentgen ray examination of the urinary tract.

Hæmaturia discernible to the patient occurred in 300 cases and was reported by an attending physician as appearing microscopically in 57 cases. From the standpoint of the patient the most alarming symptom was anuria. This occurred in 27 cases; in 22 it was evidently reflex in type since obstruction was not demonstrable in the opposite ureter. The reflex anuria did not last more than 24 hours in any case so that anuria of longer duration is probably due to obstruction.

The 5 remaining cases of the series are summarized. They are of interest in showing how rapidly the urea values of the blood will return to normal as soon as obstruction to urine is removed.

CASE 1. A man aged 56 years had had anuria for 7 days. The left kidney was functionless and a stone was present in the right ureter. The blood urea was 172 milligrams for each 100 cubic centimeters. Obstruction in the right ureter was passed by a catheter and the blood urea was normal in 5 days. Surgical procedures were advised but the relative refused operation and took the patient home, where anuria again developed and he died in 3 days.

CASE 2. A man aged 45 years had had anuria for 56 hours. Right nephrectomy had been performed 9 years previously. Stone in the lower part of the left ureter was passed by a catheter and later was removed by manipulation. The patient is now well.

CASE 3. A woman aged 73 years had had anuria for 8 days. Right nephrectomy had been performed 12 years previously. A stone was found in the upper part of the left ureter at the ureteropelvic juncture. The blood urea was 214 milligrams for each 100 cubic centimeters. A catheter was passed by the obstruction for drainage. The blood urea became normal within 6 days. The stone was removed surgically with recovery of the patient.

CASE 4. A woman aged 53 years had had anuria 60 hours. Right nephrectomy had been performed 9 years previously. A stone was found in the middle third of the left ureter. The blood urea was 220 milligrams for each 100 cubic centimeters. A catheter passed the obstruction and after 8 days of catheter drainage the blood urea became normal. The stone was manipulated. Patient recovered.

CASE 5. A woman aged 55 years had had anuria 57 hours. Right nephrectomy had been performed 4 years previously. A stone was found in the lower part of the left ureter. The blood urea was 438 milligrams for each 100

injury that nephrectomy or nephro ureterectomy was required. If these 49 are excluded, we find that 60.7 per cent of all the stones in the lower part of the ureter were removed by manipulation. We believe this is a conservative estimate as to the number of cases in which it is feasible to remove stone by manipulation, and we believe further that if an attempt is made to remove stone by manipulation in a greater number of cases, the procedure will not only fail but the incidence of suppurative pyelonephritis with multiple cortical abscesses and the mortality rate will increase. In this series such reactions occurred 32 times (11 per cent) in the 274 manipulations, including the 2 fatal cases referred to.

Efforts to deliver stones by cystoscopic manipulation should not be carried to a point at which there is grave danger of suppurative pyelonephritis. Cases which show marked infection should, we believe, be treated by ureterolithotomy, rather than by manipulation, as should cases with stones which are of more than 1.5 to 2 centimeters in diameter and which are known to have been present for a considerable period.

Reaction following manipulation can be reduced to the minimum if ureteral catheters are left in the ureter to insure drainage following the removal of the stone, for the edema produced by the manipulation, together with the resulting ureteritis and peri ureteritis, if adequate drainage is not insured, results in rapid ascending infection. When this has occurred, any delay in operating to relieve the stasis and infection greatly increases the risk. In all the cases in this series in which operation was performed as soon as signs of renal infection appeared the patients recovered. The two deaths referred to give a mortality in the series of 0.2 per cent following catheter manipulation. There were 9 deaths following the surgical treatment of ureteral stones. The majority of these cases were complicated by the presence of renal stones and poor renal function and the operation was done as a life saving measure. The mortality in the entire series of 1,001 cases was 1.1 per cent.

The operations performed in the 529 cases were ureterolithotomy 372, nephro ureterectomy, 51, nephrectomy 37, ureterectomy (nephrectomy elsewhere) 3, and combined operations, 66.

#### RECURRENTS

At the Mayo Clinic roentgenograms are made in all cases following either the surgical removal or manipulation of urinary calculi in order to make sure that if fragments are left or only a portion of multiple stones removed the cases may not, in the future, be classified as recurrences. In many

cases, of course, stones continue to form for years. In several cases in this series there was a history of many stones having passed 25 to 40 years before there was one too large to pass. Sixty-two (6 per cent) of the patients in the series are known to have had recurrence, 32 in the same ureter and 30 in the opposite ureter.

The benefit from the removal of the stone was usually immediate and permanent, as infection rarely persists after stones are removed.

No attempt was made except in individual cases, to dilate the ureter for a certain period as a prophylactic measure. The possible benefit in a few cases did not seem to justify treatment in all cases. The importance of removing all foci of infection was strongly emphasized, and they were removed whenever possible before patients were dismissed from observation.

#### BIBLIOGRAPHY

1. BEER, EDWIN. Diagnosis and treatment of ureteral calculi. *New York St J Med*, 1916 xvi 501.
2. BEER, EDWIN and HAHN, L. J. Use of indwelling catheter to induce passage of ureteral stones. *J Am M Ass* 1925 lxxxix 1028-1030.
3. BRAESCH W. *J Urol* 1921, vi 256-257.
4. BUERGER L. F. A new method of facilitating the passage of descending ureteral calculi and of dilating the ureter. *Am J Surg* 1913 xxvii 151-154.
5. BUGBEE H. G. Intra ureteral manipulation of ureteral calculus. *Tr Am Ass Genito-Urin Surg*, 1923 xvi 183-203.
6. BUMPUS H. C. JR. Ureteral scissorts. *J Am M Ass* 1924 lxxviii 1331.
7. CABOT HENRY. Errors in diagnosis of renal and ureteral calculus. *Surg Gynec & Obst* 1915 xvi 403-406.
8. CROWELL A. J. Removal of ureteral stone by cystoscopic manipulation. *J Urol* 1921, vi 243-255.
9. DOORMASHAKIN R. L. Stone in ureter. *New York St J Med* 1926 xxvi 733-740.
10. EUSTICE and NICOLAIE. Quoted by Keyser. Collected Papers Mayo Clinic 1923 xv 454-466.
11. FOLSON A. I. *South M J*, 1924 xvii 503.
12. HANSEN G. L. The etiology of ureteral calculus. *Surg Gynec & Obst* 1918 xxvii 252-270.
13. JUDS E. S. The results of operations for removal of stones from ureter. *Ann Surg* 1920, lxxi 128-130.
14. KEYSER L. D. The mechanism of the formation of urinary calculi. *Ann Surg* 1913 lxxvii 10-22.
15. LEWIS BRADFORD. *Am J Urol* 1904 i 134-163.
16. LIVERMORE C. R. Intra ureteral manipulations. *South M J* 1924 xvii 500-501.
17. ROSENOW L. C. and WEISSER J. G. The production of urinary calculi by the devitalization and infection of teeth in dogs with streptococci from cases of nephrolithiasis. *Arch Int Med* 1923 xxxi 807.
18. SMITH C. K. *Missouri St M Ass* 1925 xxii 79-88.
19. STIRLING W. C. New forceps for removal of impacted ureteral calculus. *J Am M Ass* 1917 lxxviii 924.
20. VOSE S. N. A new instrument for the cystoscopic removal of ureteral calculi. *New England J Med* 1928 cxxviii 638-640.
21. WALTHER, H. W. I. *J Urol* 1918 ii 233-236.

cystoscopic means. Such endeavor was accelerated markedly in 1921 by a paper by Crowell in which he reported removing stones from the ureter by cystoscopic means in 88 cases in a series of 95. He depended largely on the slow dilatation of the ureter by the placing of increasingly large catheters and leaving them for a day or two and he believed that the consuming of several months time in his endeavors was not contra indicated if he was finally successful in removing the stone without resorting to operation. Of course, to most urologists such delay would be a strong contra indication to the method and as Judd had recently reported 400 operations of ureterolithotomy with but a single death attributable to the operation, the more rapid surgical method would still have a strong appeal. In the discussion of Crowell's paper, Braasch pointed out that the method seems particularly applicable to small stones of recent origin and that severe reaction or acute pyelonephritis attending or immediately following manipulation must be guarded against. Stimulated by Crowell's report, many physicians undertook to remove more stones by manipulation, and individual apparatus for hastening removal of the stone either by dilating the ureter or crushing the stone, or if the stone was not too large, by bringing it out intact were rapidly developed and presented to the profession. The best known of these instruments was Stirling's ureteral forceps. The Vose stone extractor, the Dourmash kin bag, the Smith spiral filiform tip catheter, the Walther bougie with filiform guide, the Bueger olives, and the Livermore stone manipulator all proved successful in some cases but the more rapid removal of stones by these methods was bound to produce much more trauma to the ureter than the slower method of manipulation by catheter and there soon appeared in the literature reports of untoward results not usually occurring when the more leisurely methods were in vogue. Folsom said: "I want to call attention to the danger of the procedure. Cases under my observation that vividly impressed me on the day following the effort to dislodge the stone had acute suppurative nephritis. That situation can occur rather more frequently than we think. The question of a severe infection spreading rapidly following these manipulations has to be taken into consideration. Hugbee wrote: 'While all of the modern intra-ureteral instruments for the purpose of dilating and cutting the ureter, or grasping the calculus have been used and are still occasionally employed we have had better results as regards ultimate passing of the stone, less pain and traumatism incident to manipulation and an absence of infec-

tions following the simple shifting of the axis of the calculus or traction on the calculus by the use of soft ureteral bougies or catheters wedged in between the calculus and ureteral wall or coiled about the calculus." Beer and Beer and Hahn also advocate the method of simply passing a catheter by the stone and allowing it to remain for from 2 to 5 days. Beer said: "The mechanism is not clear. Perhaps the edema of the mucous membrane which holds the stone is allowed to subside perhaps some traction on and dislocation of the stone are caused by withdrawal of the catheter or perhaps dilatation of the ureter is the chief factor. Whatever the mechanism is it has two great advantages over other methods in this category: (1) a single treatment frequently suffices to deliver the stone, and (2) stones are passed with very little pain. Beer was successful in 60 per cent of his cases by this simple method."

The experience gained in this series has led us to agree fully with the foregoing quoted data. Thus we find that in 146 cases the stone passed following the manipulation incident to the first cystoscopic examination whereas in 274 other cases manipulation was followed by success in 62, in 63 of these ureteral meatotomy was done as an aid to manipulation with scissors designed by one of us (Bumpus) for the purpose or with fulguration. In 63 cases surgical removal was necessary after manipulation had failed. Eleven patients refused surgical treatment after failure of manipulation. Hunner early pointed out the danger of such delay. He said: "In the use of intra-ureteral manipulations every precaution should be used to safeguard the patient and one should be ready to operate on the first sign of renal damage or indication of exhaustion from pain." Two of these patients after the lapse of 5 to 7 days had rendered their condition critical consented to operation. Both died from sepsis. Since then we have always secured permission to resort to operation if the manipulation failed.

In 74 per cent of the cases in which manipulation was attempted the stone was removed. This percentage does not include the 146 cases in which stones were passed after a single cystoscopic manipulation. Were these cases included, the total in which manipulation was successful would be raised to 85 per cent of the cases in which it was attempted.

There were 52 cases in which stone was removed surgically from the lower third of the ureter and 28 such cases involving the upper and middle thirds. In 49 cases the urinary obstruction produced by stone in the lower part of the ureter had resulted in such extreme ureteral and renal

In the advanced stage the diagnosis of vulvar cancer is easy, in the incipient stage differentiation from sarcoma is difficult, as their clinical appearance is very similar. To diagnose vulvar cancer, excision and histological examination are necessary.

In the treatment of cancer of the vulva operation and radiotherapy are the only methods which should be considered. Radical removal of the vulva with the simultaneous extirpation of the inguinal lymph glands is advisable. Stoekel is not satisfied with this, he believes that the pelvic glands also should be removed. Such an extensive operation can be performed only if the patient is in a good condition. If the growth has reached an advanced stage and the patient is in poor condition radical operation is out of the question. We must then content ourselves with the operative removal of the local tumor and the treatment of lymph glands with radiotherapy. Since the study of the end results after operation shows frequent recurrences, operation alone cannot be said all ways to be productive of permanent cures. For this reason the adherents of operation have come to recommend the use of radiotherapy together with operation.

At first radium as a means of treating cancer of the vulva offered great hopes, but it was soon found that the improvement from such treatment was only temporary in many cases and that the percentage of permanent cures was but slightly increased.

Radiotherapy may be used even in patients belonging to that larger group—those of advanced age with extensive growths—and although permanent cure is rather exceptional, temporary improvement can generally be obtained, so that radiotherapy plays a most important rôle in the treatment of cancer of the vulva.

We generally use a high voltage current in combination with radium therapy. For local treatment radium is usually used, and lymph glands are irradiated with roentgen rays.

Radium irradiation of cancer of the vulva can be accomplished in many ways. The implantation method is widely used and is very satisfactory. Radium may be implanted with needles emanation tubes, small radium tubes, and thorium rods. Platinum needles 0.3 to 0.5 millimeters thick, each of which contains 1 to 2 milligrams of radium or condensed emanation are used. They are placed 1 to 2 centimeters apart and a sufficient number is used to cover the neoplasm. Small tubes each containing 2 milligrams of radium and fitted with a 1 millimeter platinum filter are embedded 2 centimeters apart in the tissues by means of

a special trocar. With threads attached to them these tubes can be easily withdrawn at the desired time. Local anaesthesia is used.

Institutions which have large amounts of radium have recently made use of tele irradiation in the treatment of malignant neoplasms, such as cancer of the vulva. Quantities of radium, which may amount to several grams, are placed in metal box containers of various shapes and sizes and generally lined with lead. These metal box containers are placed in cases which are attached to a stage that is movable in all directions and may be fixed at any desired distance from the skin. This arrangement is similar to that used in deep X ray therapy. With malignant tumors at very different sites can be given homogeneous X ray irradiation in several fields. Tele irradiation should not be used in private practice but should be confined to institutions which handle large amounts of radium.

In the radium treatment of vulvar cancer, columbia plates can also be used to fix the radium tubes in the proper place and at the proper distance. The widely used columbia plate, which is recommended by the Paris Radium Institute, is made by melting a mixture of beeswax, paraffin, and sawdust, and can be molded in water at a temperature of 45 degrees. We ourselves can, therefore easily make radium holders suited for any special purpose. The deeper the malignant tumor, the greater must be the skin distance.

The desired skin distance is maintained either by increasing the thickness of the plate or, still better, by melting small wax brick radium holders into the plate. The thickness of the plate usually varies between 1 and 3 centimeters. By means of a warmed instrument, filter fitted radium tubes can easily be embedded in the wax plate in the required number and at the proper distance.

On several occasions we have found the columbia plate very useful in applying radium to cancer of the vulva in that it fixes the radium tubes in suitable position and at the proper distance. So for a patient who had a very advanced growth which was the size of a large plum and involved both labia minora I molded a columbia plate with a tongue shaped flap which reached the tumor and with a base which could be attached to the symphysis. In the upper part of the flap an opening was made for the insertion of a permanent catheter. On both sides at the level of the cancerous tumor I inserted silver and brass filter fitted radium tubes which contained together 50 milligrams of radium. Between the labia, with tubes melted into a wax wedge which projected from the lower surface of the flap, I applied another 50



# RADIUM THERAPY IN THE TREATMENT OF CANCER OF THE VULVA

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CANCER of the vulva is one of the most difficult types of cancer to treat. Both operation and the use of radiotherapy so far have failed to yield the results hoped for. As far as end results are concerned, in the treatment of cancer of the vulva as in the treatment of cancer in general, the majority of surgeons consider that the most suitable procedure is operation and then the use of radiotherapy. Recently the value of radium in the treatment of cancer of the vulva has been more and more stressed as reports have been published describing the good results obtained from its use.

During the last 10 years (1918-1928) in the I Gynecological Clinic we have treated with radium and high voltage therapy 31 cases of cancer of the vulva. This is a goodly number, as cancer of the vulva is not as common as cancer in other regions, therefore, the correct supervision and follow up of these cases has enabled me to learn much regarding the value of radiotherapy in the treatment of cancer of the vulva.

Cancer of the vulva constitutes 3 per cent of the cancers of the female genitalia, it is scarcely more frequent than the rarely occurring primary cancer of the vagina. Usually we find it in older women long past the climacteric. In our series most of the patients were beyond the age of 60 years. At less than 40 years of age cancer of the vulva seldom appears, although we have treated four patients who were younger, one being 22 years old. Our oldest patient was 77 years, the youngest 22 years old. This fact indicates a wide range as to age in incidence. Of female genital cancers, cancer of the vulva occurs usually at an advanced age, often the patients are between 60 and 70 years.

We have observed the growth on all parts of the external genitalia, usually it is found on the labia majora and minora, at the site of the clitoris or the urethral orifice. Usually it originates in the epithelium of the vulva and seldom develops from the Bartholinian and sweat glands. In our series the cancerous tumor was situated in 9 cases on the labium majus, in 6 cases on the labium minus, in 7 cases on both, in 5 cases at the site of the clitoris, in 4 cases near the urethral orifice. Only once was it seen at the level of the Bartholinian gland. In this case the histological examination showed an adenocarcinoma.

Cancer of the vulva is usually primary, it may be secondary to a cancerous growth of the surrounding organs. Metastasis generally occurs through inoculation in incisional scars made in vaginal total extirpations. The etiology of vulva cancer—like that of other cancerous growths—is unknown. We cannot correlate its frequency with the number of births and abortions as in our material as in that from other clinics, 50 per cent of the patients were nulliparæ or primiparæ and secundiparæ. We might rather consider kraurosis as a favorable soil for cancer, many regard this disease of the vulva as a precancerous state.

Microscopically cancer of the vulva is generally a squamous cell epithelioma, rather exceptionally it may be an adenocarcinoma. In almost all of our cases the histological diagnosis was squamous cell epithelioma. It starts in the form of nodules of different sizes, which slough and soon necrotic ulcers with everted borders are formed. When ulceration sets in the cancerous nodules proliferate quickly and form tumors of various sizes which often occupy the whole vulva. Because of the abundant lymphatic communications of the vulva, cancer in this region is one of the most malignant types, cancer of the clitoris is especially malignant. The inguinal lymph glands soon become infiltrated and form smaller or larger tumors later on in a more advanced stage the pelvic lymph glands become involved. Besides the lymph vessels the adjoining organs will be endangered and the cancer may invade the vagina, urethra, bladder, and rectum, it may involve the connective tissue and bones of the pelvis. Metastases to distant organs seldom occur.

In the beginning cancer of the vulva does not cause remarkable disturbances. Hence many patients consult a physician only when the disease has reached an advanced stage and pains and difficulty in urination are present. The development and extension of vulvar cancer may vary. In general the course is slower in patients of more advanced age than in young patients in whom a rapid decline is sometimes observed. According to the experiences of Berecz and Lewres, pregnancy stimulates the development and extension of vulvar cancer. Death generally occurs as a result of cachexia or sepsis but is often caused by infections of the urinary tract.

In the advanced stage the diagnosis of vulvar cancer is easy, in the incipient stage differentiation from sarcoma is difficult, as their clinical appearance is very similar. To diagnose vulvar cancer, excision and histological examination are necessary.

In the treatment of cancer of the vulva operation and radiotherapy are the only methods which should be considered. Radical removal of the vulva with the simultaneous extirpation of the inguinal lymph glands is advisable. Stoeckel is not satisfied with this, he believes that the pelvic glands also should be removed. Such an extensive operation can be performed only if the patient is in a good condition. If the growth has reached an advanced stage and the patient is in poor condition, radical operation is out of the question. We must then content ourselves with the operative removal of the local tumor and the treatment of lymph glands with radiotherapy. Since the study of the end results after operation shows frequent recurrences, operation alone cannot be said all ways to be productive of permanent cures. For this reason the adherents of operation have come to recommend the use of radiotherapy together with operation.

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Radiotherapy may be used even in patients belonging to that larger group—those of advanced age with extensive growths—and although permanent cure is rather exceptional, temporary improvement can generally be obtained, so that radiotherapy plays a most important rôle in the treatment of cancer of the vulva.

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On several occasions we have found the columbia plate very useful in applying radium to cancer of the vulva, in that it fixes the radium tubes in suitable position and at the proper distance. So for a patient who had a very advanced growth which was the size of a large plum and involved both labia minora. I molded a columbia plate with a tongue shaped flap which reached the tumor and with a base which could be attached to the symphysis. In the upper part of the flap an opening was made for the insertion of a permanent catheter. On both sides at the level of the cancerous tumor I inserted silver and brass filter fitted radium tubes which contained together 50 milligrams of radium. Between the labia, with tubes melted into a wax wedge which projected from the lower surface of the flap, I applied another 50

milligrams of radium. In all a dosage of 4,500 milligram element hours was given. On the fourteenth day after treatment, the cancerous tumor had diminished to one tenth of its former size. 33 days after treatment it had almost entirely disappeared. We irradiated the lymph glands by means of the roentgen rays. In several instances this method proved to be successful.

Radium gives somewhat more encouraging results in the treatment of vulvar cancer than in the treatment of vaginal cancer. As cancer of the vulva is rare there are not sufficient data on which to base definite opinions as to the value of radiotherapy. Therefore, we must base our conclusions on the few reports in the medical literature.

Of 31 patients with carcinoma treated with radium at our clinic during the period 1918-1928, 2 were free from recurrence 6 years later. One lived 4 years after radiotherapy, 2 lived 3 years, 3 lived 2 years, 5 lived 1 year, 7 died within 1 year, and in 7 the duration of life is unknown. Besides 2 free from recurrence 6 years after treatment 4 other patients are under observation.

After excision and microscopical diagnosis, patients with cancer of the vulva to be treated with radiotherapy are given a single radium ray dose amounting to 1,200 to 2,400 milligram element hours, if possible. Then if at control examination the effect seems to be unsatisfactory the radium treatment is repeated in 6 to 8 weeks. For irradiation of the lymph glands we use roentgen rays, a pigmentation dose is applied three times at intervals of 6 weeks. Patients treated with radiotherapy are instructed at the end of treatment to return for examination every 3 months, later every 6 months. Those who do not come back are followed up by letter.

Our results compare favorably with those reported in the literature, especially when we consider that in the majority of our patients the growth had reached an advanced stage.

At the II Gynecological Clinic of Budapest University, Gál was able to obtain improvement for 3 years in one of 5 cases which were treated with combined radium and X ray therapy.

Heymann of the Stockholm Radium Institute reports the largest number of cases. Of 64 patients

treated with radium and X ray therapy 3 were cured for longer than 5 years. 11 patients who were under observation for a period ranging from 1 to 4 years were improved.

Of 13 patients treated with radium Bumm reports 4 cured.

Of 9 cases reported by Amreich 2 were cured with radium therapy, while 2 had recurrence after 2 and 3 years respectively.

Kehrer recommends a combination of surgical and radiotherapy in the treatment of cancer of the vulva. He removes the lymph glands and then destroys the tumor with cautery, and treats the stump with radium.

Proust also claims good results from combined operative and ray treatment.

Matthel recommends for cauterization of the cancerous growth deep coagulation by means of diathermy.

In the Brussels Radium Institute, of 21 cases of cancer of the vulva, Delporte and Caben treated 3 with radium implantation and X rays, 4 were treated with radium implantation and external radium irradiation. In 4 cases the glands were removed surgically and the tumor treated with radium implantation and high voltage irradiation. The patients were observed for 2 years. At the end of this period, 5 of the 21 patients were alive. The best results were obtained in the last group which included 4 patients treated with surgery and radiotherapy. Three of them are living after years.

#### SUMMARY

There is no doubt that treatment of cancer of the vulva is a most arduous task. Of the methods of treatment at our disposal, radiotherapy ranks first, not only because it can be used in advanced cases, but also because in most instances its use improves the condition or at least ameliorates the suffering and in a few cases even permanent cure has been secured. In most cases radiotherapy produces a temporary improvement and delays death at any rate the life of the victim is made tolerable. Even the few cures obtained, to say nothing of the palliative effect which it produces make radiotherapy indispensable in the treatment of cancer of the vulva.

THE PRESENT DAY TREATMENT OF PLACENTA PRÆVIA<sup>1</sup>

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**B**y placenta prævia is meant the development of part or all of the placenta in the zone of dilatation of the uterus. We generally consider three degrees of this condition, namely (1) central or total placenta prævia in which the placenta completely covers the internal os, (2) partial or lateral placenta prævia in which the placenta covers only part of the internal os, and (3) marginal placenta prævia in which the lowest edge of the placenta just reaches the internal os. The strict differentiation of these types should not be made until the cervix is fully effaced and dilated, but we generally institute treatment long before this stage is reached.

## INCIDENCE AND ETIOLOGY

The incidence of this obstetrical complication is difficult to determine, because statistics from various parts of the world indicate that in some places it occurs once in 130 cases and in other regions only once in 1,500 cases. The exact cause is unknown but a large number of women have previously had some endometrial disease or disturbance. Multiparae are affected about ten times as frequently as primiparae. The more the number of children and the greater the rapidity with which the pregnancies follow each other, the greater is the incidence of placenta prævia.

## DIAGNOSIS

The diagnosis of placenta prævia is relatively easy. Textbooks teach that a painless causeless, uterine hemorrhage in the third trimester of pregnancy is almost pathognomonic of placenta prævia. Regardless of the amount of blood lost during the first hemorrhage unless treatment is instituted there are recurrences of bleeding each of which is generally greater than the preceding one. Labor usually begins after the second or third hemorrhage. If on vaginal examination a portion of the placenta is found lying over the internal os the diagnosis of placenta prævia is confirmed provided we rule out the very rare instances of prolapse of the normally implanted placenta.

It must be borne in mind that in nearly all cases of placenta prævia the diagnosis can be made without a vaginal examination. This and even rectal examination may be dangerous procedure, because of the serious bleeding which may

result. An internal examination should not be made unless all preparations are at hand for the proper and aseptic control of bleeding should this occur. Patients who have a hemorrhage should be sent to a hospital without preliminary internal examination.

Sources of bleeding other than placenta prævia such as polyps, varicose veins the bladder, and carcinoma of the cervix can easily be eliminated by a careful examination. However, it may be difficult to differentiate placenta prævia from abruptio placenta, especially if there is partial separation of a low lying placenta. There may also be confusion with rupture of the uterus, ectopic gestation, and bleeding from a vessel which passes over the cervical os because of a velamentous insertion of the cord. However, most of these conditions make hospital care imperative hence a physician will do the proper thing if he sends to a hospital all patients who have hemorrhage from the vagina.

## MORTALITY

The mortality from placenta prævia varies considerably in different parts of the world and in different localities of any particular country. According to De Lee the maternal mortality reported from twenty different sources varies from 1 to 19 per cent and the fetal mortality varies from 10 to 80 per cent. Hirschmann in 1921 collected 6,438 cases and found a total maternal mortality of 6.5 per cent and a total fetal mortality of 40 per cent. However, it is generally agreed that collective statistics are hard to evaluate. Much depends upon the condition of the patient, the duration of pregnancy, the type of placenta prævia, the surroundings of the patient, and the skill of the attending physician.

Most of the maternal deaths in placenta prævia are due to hemorrhage, septicæmia and rupture of the lower uterine segment. The fetal deaths are generally due to asphyxia (from diminished or absent blood supply), prematurity, injury during version or extraction, and monstrosities.

## TREATMENT

There are four commonly used methods of treating placenta prævia namely rupture of the membranes with or without firm packing of the vagina, Braxton Hicks podalic version the

<sup>1</sup>Read before the Chicago Medical Society January 26 1929 and the Portland (Oregon) Academy of Medicine, March 19 1929.

colpeurynter and caesarean section. The type of operation to be performed in any case will depend upon the degree of placenta previa, whether the patient is in labor or not, the amount of dilatation of the cervix, the surroundings, the condition of the mother and the child, and the skill of the attending physician.

At the outset it may be said that a distinction should be made between treatment in the home and treatment in a hospital. As previously mentioned, every patient who has a placenta previa should be sent to a hospital. Nowadays with the large number of hospitals available and with the aid of automobiles and auto ambulances which greatly facilitate and hasten transportation, there is practically no excuse for treating a patient with placenta previa in her home. Furthermore, unless a woman is bleeding very actively when the physician arrives, it is not necessary to pack the vagina. In the few cases where this is imperative, the greatest aseptic precautions should be taken, and sterile cotton pledgets are much better for packing than gauze. The packing should fill the entire vagina firmly, and counterpressure should be made from above with a firm abdominal binder.

If a patient must be treated in her home, a careful vaginal examination should be made, and if the cervix is undilated, it is best to rupture the membranes and combine this with a firm vaginal pack consisting of cotton pledgets. When it appears that there is sufficient dilatation of the cervix, a Braxton Hicks version should be performed. Complete relaxation of the abdomen and uterus are necessary for this; hence an anesthetic must usually be given for a few minutes. One foot is brought down with the fingers or with a long placenta forceps. The breech of the fetus is thus used as a tampon to control bleeding. The physician must wait for nature to expel the child and he should not leave the patient until the child and placenta are delivered and all bleeding has ceased. Haste in delivering the fetus through a partially dilated cervix will in many cases result in deep lacerations of the lower uterine segment with much hemorrhage which is difficult to control. Never should the cervix be dilated rapidly by means of the hand or instruments because extensive tears usually result and death is the frequent termination. Salt solution or a blood transfusion should be given at home as well as in a hospital.

In a hospital the treatment will vary with many conditions. If the patient is in labor and there is complete effacement and dilatation of the cervix, the child should be delivered by forceps or version and extraction, depending upon the station of the head. If the cervix is not completely dilated, and

there is not much placental tissue over the internal os, rupture of the membranes may suffice. If the child is dead or not viable and there is considerable placental tissue over the cervix, a Braxton Hicks version may be performed and a leg brought down. Extraction should not be completed until the cervix is sufficiently dilated to permit very easy extraction of the fetus. This treatment is identical with that which can be carried out in a home for similar conditions. However, in a hospital if the child is alive, a metrectomy may more properly be inserted into the lower uterine segment after rupturing the membranes or tearing through the placenta. The bag should be sufficiently large so that after it is forced through the external os there will be enough dilatation of the cervix to permit passage of the fetal head or easy version and extraction. A liberal amount of mercurochrome, heptylresorcinol or other safe antiseptic should be poured into the vagina preparatory to and with the insertion of the bag as well as for any manipulation through the vagina.

Very little traction should be made on the bag, and pituitrin should never be given before delivery of the child. The physician must carefully watch the patient and determine, especially by rectal examination, the exact time when the bag is almost ready to be expelled from the cervix. Preparations should then quickly be made for delivery because not infrequently there is considerable bleeding after the bag slips through the cervix. If the head follows the bag through the cervix, the baby should be delivered without delay, either by permitting it to come out spontaneously or with the aid of forceps. If however the head remains high, version and extraction should be performed, provided there is sufficient dilatation of the cervix. If there is incomplete dilatation, version alone should be performed but not extraction because a rupture of the lower uterine segment might result.

The treatment of the third stage is very important because additional hemorrhage at this time, even though small in amount, may be fatal to the patient. If there is little bleeding, one may safely wait for spontaneous separation of the placenta. If however, there is active bleeding, the placenta should be removed manually, but under the strictest aseptic precautions. The patient may be saved from a death due to hemorrhage but she may die of sepsis unless the technique of invading the uterus is as perfect as possible. An antiseptic such as mercurochrome or heptylresorcinol may here be used advantageously. If bleeding continues after removal of the placenta, one must make certain there is no rupture of the uterus. If there is none and pituitrin fails to arrest the

hæmorrhage, the uterus and vagina should be packed firmly without delay. Rupture of the uterus may be treated by tamponade or by laparotomy, depending upon the conditions present, but preferably by laparotomy.

Another expedient of controlling hæmorrhage which is relatively simple and safe, is temporary clamping of the uterine arteries from below, by means of bullet forceps placed on the broad ligaments (Henkel) or ligation of these arteries with sutures (H. Miller Kervin). Likewise, compression of the aorta with the hand, or an aorta compressor applied for a few minutes, may enable the physician to make preparations for the control of hæmorrhage.

Occasionally a patient refuses to have the uterus emptied because the child is not viable. One may temporize only if the bleeding is slight and the patient is willing to remain in a hospital until she is delivered. The uterus should be emptied as soon after viability as possible. The risk of repeated and more profuse hæmorrhages is too great to permit a patient to remain at home and even in a hospital undelivered.

The most modern treatment of placenta prævia is by means of cesarean section. A few individuals like Diehrssen, Doederlein, Essen Moeller, and E. Martin employ the vaginal route, but most obstetricians who deliver placenta prævia patients by cesarean section employ the abdominal route.

According to De Lee four objects should be accomplished in the treatment of placenta prævia, namely: the hæmorrhage should be stopped, the uterus emptied, hæmostasis insured, and anaemia combated. The most certain way to empty the uterus, control the bleeding during delivery and prevent postpartum hæmorrhage is abdominal cesarean section. This operation combined with blood transfusion before, during, or after the operation yields better results than does any other procedure used in the treatment of placenta prævia. At the Chicago Lying in Hospital, the total maternal mortality in a series of 118 cases of placenta prævia was 2.6 per cent. Of the 3 deaths, one followed spontaneous delivery and the two others occurred after version and extraction. Cesarean section was performed 42 times, and there was not a single maternal death in this group. Hence the mortality for the so-called conservation methods was 3.9 per cent. Eight of the cesarean sections were classic and 34 were low, cervical ones.

Bill recently reported a series of 45 cases in which cesarean section and transfusion were not very frequent and in which the maternal mortality was 11.1 per cent. He compares this group with a series of 56 cases in which 71.4 per cent were de-

livered by cesarean section, with only one death (1.78 per cent). Blood transfusion seemed to be indicated in about one fifth of these cases.

Frey, in Zurich, reported a series of 88 consecutive cases of placenta prævia all of which were delivered by cesarean section and only one mother died. The cause of death was an inoperable gastric carcinoma and ileus. In the discussion of this paper Labhard said in an almost similar number of cases treated by abdominal operation, he did not lose a single mother.

In Germany the number of advocates of cesarean section for the treatment of placenta prævia has recently increased considerably. Not only are clean cases being treated by abdominal operation but also those in which vaginal examinations were made without regard to asepsis. In a series of 168 cases of placenta prævia von Mikulicz Radecki reported a maternal mortality of 11.5 per cent for the older methods and only 3.3 per cent for cesarean section. In a recent paper Korthauer points out that in his series, the maternal mortality for patients delivered by version and extraction was 50 per cent, for those delivered by Braxton Hicks version, 11.1 per cent, and for those on whom cesarean section was done only 6.9 per cent.

Siegal advocates abdominal cesarean section for placenta prævia in every case which has advanced beyond the thirty-second week, regardless of whether the child is dead or alive, to avoid danger to the mother. The danger consists in laceration and lack of retraction of the isthmus, which can occur whether the fetus is dead or alive. Kellogg of Boston, believes that all patients with central or partial placenta prævia are best treated by abdominal cesarean section whether the baby is viable or non viable, living or dead.

From the foregoing it appears that cesarean section yields the best results in the treatment of placenta prævia for patients who are in hospitals and in the hands of specialists. We at the Chicago Lying in Hospital advocate the cervical type of operation (laparotrachelotomy), because of its numerous general advantages over the classic operation. At this hospital in a series of 807 cervical cesarean sections there were only 9 deaths from all causes, an incidence of 1.1 per cent. I, personally, have performed 101 low cervical cesarean sections without a single maternal death. This series includes private patients, patients seen in consultation, and ward patients treated at the Chicago Lying in Hospital. The cervical section permits careful inspection of the lower uterine segment which is the usual source of the severe hæmorrhage in cases of placenta prævia. Not infrequently a large torn sinus

will be found in the lower uterine segment, and bleeding from this sinus can easily be controlled by suture. Such bleeding sinuses can seldom be seen during the course of a classic operation and they may continue to bleed not only during but also after the operation. There is no more reason to fear encountering the placenta when performing the low operation than when doing the classic one. If there is a strong suspicion of infection in a patient who has a number of living children it is wiser to perform a Porro operation. The recovery is then much smoother. If definite infection is present and a caesarean operation is done, the uterus should be amputated regardless of the number of living children the patient has unless one is willing to perform the Gottschalk Portes exteriorization operation.

Because of the not infrequent association of fetal monsters with placenta prævia as shown by the author, one should not too strongly advocate abdominal operation in the interest of the baby without first making reasonably certain it is not a monster. At the Chicago Lying in Hospital during the past 9 years, almost half of the monsters encountered were associated with placenta prævia. This condition can usually be detected by means of an X-ray picture. If a patient has a central or partial placenta prævia and has lost a great deal of blood a caesarean section should be done even in the presence of a monster, because the operation is performed in the interests of the mother and not the child. If a patient has suffered much loss of blood she should be transfused preferably before operation. If a blood transfusion is not deemed necessary or cannot be given glucose or saline solution should be administered subcutaneously or intravenously. Furthermore, to eliminate an additional serious risk, local anesthesia should be used wherever possible. Even if a Porro operation is necessary this also may readily be performed under direct infiltration anesthesia as described.

All danger is not over with the operation. The patient must be watched for postpartum hemorrhage, but this rarely occurs after the cervical caesarean section. Sepsis is another serious complication and this likewise is much less frequent following laparotomy than after extensive vaginal manipulation. Transfusion should be repeated if necessary.

#### SUMMARY

In recapitulation I should like to urge that all patients who have a painless causeless hemorrhage in the last trimester of pregnancy be immediately sent to a hospital without having a vaginal examination made and without a vaginal pack unless this is absolutely necessary. Because

of paved roads, smooth running automobiles, and the large number of accessible hospitals, there is seldom need to treat a patient with placenta prævia in her home or to pack the vagina before sending her to a hospital. I believe the best treatment for cases of central or partial placenta prævia is the low cervical caesarean section under local anesthesia. Blood transfusion should be thought of and used more frequently than it is today. In infected cases the uterus should be amputated after the baby is removed. For cases of marginal placenta prævia and for a certain proportion of cases of partial placenta prævia the older methods such as rupture of the membranes with or without vaginal tamponade, Braxton Hicks version, and metrecruris should be employed. As De Lee points out in former years when confronted with a case of placenta prævia we first thought of the old methods of treatment and only lastly of caesarean section. Now the process is reversed for we usually think of caesarean section first.

In this paper little consideration has been given the child because it is secondary in importance to the mother. However caesarean section is the most certain way of delivering a baby alive, and it will save every baby which is not too premature or a monstrosity. In cases of central or partial placenta prævia with severe hemorrhage the abdominal route is advocated regardless of the condition of the child. Placenta prævia is unfortunately one of the conditions which will continue to occur for a long time because as yet we know no certain way of preventing it. Our aim, therefore is to prevent loss of life and this can best be accomplished in severe cases by the cervical caesarean section.

#### BIBLIOGRAPHY

1. *Bull. Am. J. Obst. & Gynec.* 1917 xiv 323
2. *De Lee*. The Principles and Practice of Obstetrics
3. *Döderlein*. *Zentralbl. f. Gynaek.* 1911 xxvi 938  
*Arch. f. Gynaek.* 1910 xcii 91
4. *Dührssen*. *Berl. klin. Wechnscr.* 1909 xlii 2241
5. *Fisch Moeller*. *Am. J. Obst. & Gynec.* 1918 xv
6. *Luey*. *Zentralbl. f. Gynaek.* 1918 li 245
7. *Greenhill*. *Surg. Gynec. & Obst.* 1913 xxxvi 227
8. *Idem*. *J. Am. M. Ass.* 1918 xc 103
9. *Hekel*. *Deutsche med. Wechnscr.* 1915 1139
10. *Hirschmann*. *Die Therapie der Placenta prævia*.  
*Berlin*. F. Karger 1921
11. *Kellogg*. *Am. J. Obst. & Gynec.* 1916 xi 164
12. *Kerwin*. *Am. J. Obst. & Gynec.* 1917 xiv 189
13. *Kortbauer*. *Zentralbl. f. Gynaek.* 1917 li 1434
14. *Labhardt*. *Zentralbl. f. Gynaek.* 1917 li 1014
15. *Martin*. *F. Monatschr. f. Geburtsh. u. Gynaek.*  
1918 lxxviii 61
16. *Miller*. *H. Am. J. Surg.* 1909 xxiii 12
17. *Stegell*. *Monatschr. f. Geburtsh. u. Gynaek.* 1916  
lxxiii 18
18. *Miklicicz Radecki*. *Arch. f. Gynaek.* 1914 cxxiii 43

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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JANUARY 1930

#### ANÆSTHESIA

WHEN I began the practice of medicine chloroform was the anæsthetic in general use. In the medical profession there was a feeling, perhaps well founded, that if a patient was suffering at the time the operation was performed, so that the pain produced a greater effect on the patient's mind than the fear of the operation, chloroform, if given by the drop method, was a safe anæsthetic. This was considered especially true in obstetrical procedures. It was quite noticeable, however, that when chloroform was given for surgical purposes, the most responsible man gave the anæsthetic. I was never quite sure whether this was because of his supposedly greater skill or whether it was to satisfy the relations and friends, if a catastrophe occurred, that everything had been done that could be done.

Chloroform was looked on as a special danger to the heart. On one occasion when I supposed that the anæsthetist was using ether, two patients had failure of respiration from which they nearly died, and it was not until I was operating on the second patient

that I noticed the odor coming from the anæsthetic was that of chloroform and not ether. In neither of these cases did the heart show serious reduction in volume or rate.

In the early days of surgery the A. C. E. mixture was popular as an anæsthetic. It consisted of one part of alcohol, two parts of chloroform, and three of ether, and was given by the drop method. Later, ether came into favor and eventually became the anæsthetic of choice, but at times it caused irritation of the bronchial tubes and the throat, and usually was followed by nausea and vomiting.

For short operations, nitrous oxide was popular, but gave little or no relaxation, and for abdominal work had to be combined with morphine or ether or other anæsthetic.

Recent advances in methods of inducing anæsthesia have brought, in ethylene, a splendid and safe anæsthetic, which is much less irritating than ether, but which does not produce quite so complete relaxation. It can be readily combined with ether, or can be used to follow nitrous oxide, and although it has the disadvantage of being extremely inflammable, in a period of years we have had no accident of any kind from its use.

Acetylene has a field of usefulness, especially for certain operations on the chest.

In those patients in whom breathing is more or less interrupted during the administration of any anæsthetic, Lundy has demonstrated the great value of the use of carbon dioxide to stimulate respiration.

Lundy and McCuskey and their coworkers have found the use of combinations of general anæsthetics of various types, especially of ethylene with ether or nitrous oxide, in



will be found in the lower uterine segment, and bleeding from this sinus can easily be controlled by suture. Such bleeding sinuses can seldom be seen during the course of a classic operation and they may continue to bleed not only during, but also after the operation. There is no more reason to fear encountering the placenta when performing the low operation than when doing the classic one. If there is a strong suspicion of infection in a patient who has a number of living children it is wiser to perform a Porro operation. The recovery is then much smoother. If definite infection is present and a caesarean operation is done, the uterus should be amputated regardless of the number of living children the patient has unless one is willing to perform the Gottschalk Portes exteriorization operation.

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#### BIBLIOGRAPHY

- 1 BILL, Am. J. Obst. & Gynec. 1927 xiv 523
- 2 DE LEE, The Principles and Practice of Obstetrics
- 3 DOEDERLEIN, Zentralbl. f. Gynaek. 1911 xxxv 935
- Arch. f. Gynaek. 1910 xciv 91
- 4 DUEHRSSEN, Beil. klin. Wchnschr. 1909 xlvii 2241
- 5 ESSEN MOELLER, Am. J. Obst. & Gynec. 1928 xv
- 6 FREY, Zentralbl. f. Gynaek. 1923 lii 243
- 7 GREENHILL, Surg. Gynec. & Obst. 19 3 xxxvi 27
- 8 IDEM, J. Am. M. Ass. 1928 xc 1023
- 9 HENKEL, Deutsche med. Wchnschr. 1923 1139
- 10 HITSCHMANN, Die Therapie der Placenta prævia
- Berlin F. Karger 1921
- 11 KELLOGG, Am. J. Obst. & Gynec. 19 6 xi 194
- 12 KERWIN, Am. J. Obst. & Gynec. 1927 xiv 189
- 13 KORTHAUER, Zentralbl. f. Gynaek. 1927 li 1434
- 14 LARRAUDY, Zentralbl. f. Gynaek. 1927 li 1074
- 15 MARTIN, E. Monatschr. f. Geburtsh. u. Gynaek. 1928 lxxviii 64
- 16 MILLER, H. Am. J. Surg. 1909 xxxii 1
- 17 SIEGEL, Monatschr. f. Geburtsh. u. Gynaek. 1926 lxxviii 18
- 18 MIELLICEZ RADECKI, Arch. f. Gynaek. 19 4 cxxiii 243

same person. A great many patients have been, and are, treated for heart trouble because of a rapid pulse. A careful study of this group of patients not infrequently discloses cases of hyperthyroidism of comparatively long standing.

Some of the most striking cases of hyperthyroidism associated with other diseases are those which are occasionally precipitated by a surgical procedure other than thyroidectomy. Some such cases have been observed. In one patient, who had been subjected to partial gastric resection for ulcer, the pulse rate was 160 each minute on the second post-operative day. Hemorrhage, delayed shock, and peritonitis were all considered and satisfactorily ruled out. The patient's temperature was 101.6 degrees F. In spite of this slight elevation of temperature, the chief complaint of the patient was intolerance of heat, and nervousness, neither of which he complained of before operation. These symptoms suggested the possibility of hyperthyroidism. Examination of the thyroid gland showed it to be barely palpable. Nevertheless, the more common causes of such symptoms following surgical procedures had been ruled out and large doses of compound solution of iodine were administered. Within 48 hours the pulse rate had decreased to 100 each minute, the nervousness had markedly subsided, and general improvement was evident. Administration of iodine was continued for 2 weeks, when the metabolic rate was determined and was

found to be +26 per cent. A few weeks later, partial thyroidectomy was performed. The thyroid gland was the site of diffuse parenchymatous hypertrophy. A careful review of the patient's history disclosed the fact that for several years symptoms characterizing peptic ulcer had been present. The patient had become slightly nervous and had lost weight 2 months before operation. These were not outstanding features of his history and were possibly attributed to the peptic ulcer.

Another similar case was that of a young woman who was operated on because of acute purulent appendicitis. All the classical symptoms of this condition were present. Three days after appendectomy, a pulse rate of 170 and a temperature of 102.6 degrees F suggested the diagnosis of peritonitis. The extreme nervousness and tachycardia led to a diagnosis of exophthalmic goiter. The gland was only slightly palpable. Treatment with iodine was begun, and 3 weeks later partial thyroidectomy was performed. Microscopic study of the removed gland gave the characteristic picture of exophthalmic goiter.

These two cases emphasize the importance of the fact that hyperthyroidism may be present to a mild degree in association with some other disease. A surgical procedure in such cases may precipitate hyperthyroidism which, if not recognized and treated, will eventuate in crisis and perhaps death.

C F DIXON

connection with local anesthetics, to be the procedure of choice in a very considerable number of cases

In all cases, liberal amounts of oxygen have been found advantageous

The lungs have nothing to do with inducing anesthesia so far as sleep and relief from pain are concerned except as an entry way through which the inhaled anesthetic substance passes into the blood stream whence it is carried to the central nervous system. In this process irritation may arise in the lungs possibly causing serious pulmonary complications

With the new anesthetics for instance, the sodium salts of the barbituric acids and others of that type we at least have achieved a scientific method of injecting the anesthetic intravenously thereby relieving the lungs and other organs of certain dangers to which we have become so accustomed as almost to have forgotten the reason for their existence. This agent is not the perfect anesthetic, but in several hundred cases in which it has been used, we have had no fatalities that could be traced to the anesthetic

Our experience with sodium iso amyl ethyl barbituric acid demonstrates that direct methods of producing anesthesia may soon be expected, which in connection with approved methods of inducing regional anesthesia, will relieve the patient of unnecessary dangers to unoffending organs. Certainly as far as sodium iso amyl ethyl barbituric acid is concerned, the speed with which the patient drops asleep and the freedom for some hours after operation from all painful sensation has led many patients who have had unpleasant experiences with general anesthetics to plead to be operated on under this newer form

Regional anesthesia by procaine has a large and growing field of usefulness, and is

efficient and safe. Spinal anesthesia induced by procaine has proved of very great value in operations on those organs which lie below the diaphragm and this form of anesthesia is the one that should be used in cases of intestinal obstruction, because in this condition, even if the contents of the stomach have been thoroughly removed by tubing previous to giving a general anesthetic antiperistalsis may occur, regurgitating back into the stomach, esophagus and pharynx a quantity of intestinal secretions which may be aspirated into the lungs causing fatal bronchopneumonia, or even drowning on the operating table

Spinal anesthesia has the great advantage in cases of probable intestinal obstruction that if no true mechanical obstruction exists, gas and perhaps intestinal contents will pass by the rectum within 15 or 20 minutes. Therefore if gas and intestinal contents are not passed after a spinal anesthetic has been administered, mechanical obstruction may be assumed to be present and advantage can be taken of the anesthesia for immediate operation

W J Mayo

## UNDIAGNOSED HYPERTHYROIDISM

**H**YPERTHYROIDISM in patients with easily recognized goitrous thyroid glands is not difficult to diagnose. The abundance of literature on goiter has made the medical profession as a whole familiar with the symptoms which characterize the disease. The patient with hyperthyroidism who passes through the hands of many physicians and whose condition remains undiagnosed, is one in whom the symptoms of the disease are not clearly defined and perhaps some are absent. It is not uncommon, however to lose sight of the fact that two or more diseases may exist simultaneously in the



WILLIAM SHIPPEN JR  
1736-1803

# MASTER SURGEONS OF AMERICA

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## WILLIAM SHIPPEN, JUNIOR

**W**ILLIAM SHIPPEN, Junior, was born in Philadelphia in 1736, the son of Dr William Shippen, who was the grandson of that Edward Shippen who emigrated from Massachusetts to assist William Penn in founding Pennsylvania, of which colony "he filled, successively, almost all the important offices of the government "

William Shippen, senior, studied medicine in America under a preceptor only, but he attained success and eminence in his profession. Always a friend of learning, he was one of the founders of the College of New Jersey (Princeton) and long a trustee, was a trustee in the College of Philadelphia (Univ. of Penna.) vice president of the Philosophical Society, and the first physician appointed to the Pennsylvania hospital. He saw to it that his son received the best educational opportunities. That son was sent to Nottingham Academy where he came under the instruction of Reverend Mr Finlay, who gave him solid grounding in the classics. Later he attended the College of New Jersey, where he shone in classical learning and in oratory and became valedictorian for his class, that of 1757. Upon this occasion his Latin oration was delivered with such eloquence that the famous preacher Whitefield, who was present, was moved to praise the young man extravagantly and to urge him to enter the ministry. Instead, he returned to Philadelphia and for three years studied medicine with his father. At the conclusion of that period he went to London, where he lived in the family of John Hunter and studied anatomy and midwifery under William Hunter. Later he went to Edinburgh, where he graduated in 1761, his thesis being entitled "*Dissertatio anatomica medica de Placentæ cum Utero Nexu* "

In 1762 he returned to Philadelphia and took up practice and teaching. His return was preceded by a gift to the Pennsylvania Hospital from Dr John Fothergill, of a set of handsome anatomical paintings and a letter which indicated that Fothergill expected Shippen to explain these pictures and use them in teaching. He also spoke of the probability that Shippen would establish a medical school, and spoke of Dr John Morgan as Shippen's able young assistant in the project.

Shippen began to teach anatomy at once, and in his opening lecture he proposed the establishment of a medical school. He also lectured on midwifery.

Morgan did not return to Philadelphia for three years, but when he did so, in 1765, he was armed with a strong letter from the proprietor, Thomas Penn. He proposed the establishment of a medical school, in a speech the delivery of which used two days. The trustees of the College of Philadelphia accepted the proposal and Morgan was elected professor of theory and practice of physic.

Shuppen thereupon wrote to the trustees, reminding them that the establishment of a medical school had been his dearest wish for seven years, that he had proposed the matter in 1762, and asking the appointment as professor of anatomy and surgery. This was granted. It seems clear that there was a rivalry between Morgan and Shuppen for the honor of being founder of the medical school and Father of American Medicine. It is not highly improbable that the continuance of this rivalry led to the quarrels between these men in Revolutionary days and possibly to the scandalous charges and other troubles experienced by each as director general of the Hospital. Except to note that both men were highly successful and highly esteemed during all the period, we may skip the interval from the founding of the medical school until the Revolutionary War.

In October, 1775, Dr Benjamin Church having been detected in correspondence with the enemy and dismissed from office, Dr Morgan was appointed by Congress to succeed him as director general and physician in chief of the Hospital. Some months later, in July, 1776, Dr Shuppen was appointed director of the Hospital of the Flying Camp in New Jersey.

Soon after, Congress began to curtail Morgan's power and authority and to increase those of Shuppen, and in January, 1777, Morgan was dismissed, and Shuppen was given his position as director general in April.

Morgan at once began to seek vindication, which Congress granted him in 1779 in a resolution declaring that he "did conduct himself ably and faithfully in the discharge of his office." Morgan, Benjamin Rush, James Tilton, and others continued to make serious charges against Shuppen, who was brought to trial before a military commission in August, 1780, and was honorably acquitted. In January, 1781, he resigned from the service and returned to private practice and teaching. Except for one winter, 1776-7, he had kept up his lectures each year while in the army. He was considered an extraordinarily fine lecturer. Success in teaching anatomy and obstetrics required outstanding personality, as public opinion did not approve of dissection or of men midwives. On one occasion Shuppen issued the following public statement as to his procurement of anatomical material: "The Doctor with much pleasure improves the opportunity to declare that the report is absolutely false, and to assure them (the public) the bodies he dissected were either of persons who had wilfully murdered themselves, or were publicly executed, except now and then one from the Potters' field, whose death was owing to some particular disease, and that he never had one body from the church, or any other private burial place."







The advertisement for his first course of lectures on midwifery began as follows

"Dr Shippen, Jun, having been lately called to the assistance of a number of women in the country in difficult labors, most of which were made so by the unskilled old women about them, the poor women have suffered extremely and the little ones were entirely destroyed, whose lives might have been easily saved by proper management, and being informed of several desperate cases in the different neighborhoods which had proved fatal to the mothers, as well as their infants, and were attended with the most painful circumstances, too dismal to be related, he thought it his duty immediately to begin his intended course of lectures on midwifery, and has prepared a proper apparatus for that purpose, in order to instruct those women who have had virtue enough to own their ignorance, and apply for instruction, as well as those young gentlemen, now engaged in the study of that useful and necessary branch of surgery, who are taking pains to qualify themselves to practice in different parts of the country, with safety and advantage to their fellow creatures "

After lecturing and practicing medicine, surgery, and obstetrics for some ten or twelve years after leaving the army, Shippen suffered a severe blow in the illness of his only son, a young man of charming personality and brilliant promise, in whom he delighted and for whom he lived. After six years of illness this son died and Shippen lost interest 'in every remaining object "

" Then like a lamp within him died  
The flame of his magnificence "

For another ten years he lived and taught but mainly he gave himself up to religion. His health failed and in the summer of 1808 he was "attacked by an anthrax, which so much increased his debility that he sunk under it on the eleventh of July "

He was learned eloquent, equable and kind. He had a pleasing personality and a fine sickroom presence. He guided the medical department of the American Army during a considerable part of the Revolutionary War. He was a co founder of the first American medical school, a noted and pioneer teacher a skilled surgeon and obstetrician. He looms large in the history of American Surgery.

P M ASHBURN

#### REFERENCES

- Eulogium on William Shippen M D By CASPER WISTAR M D Phila J M & Phys Sc 18 2 v 173  
 Professor Morgan Retrospective Review North American M & S J 1827 iv 36  
 John Morgan By M I WILBERT Am J Pharm 1904 Jan 1  
 William Shippen Jun By JAMES EVERETT PILCHER J Ass Md Surg 1904 xiv 61  
 Caldwell Charles Eulogium of William Shippen Philadelphia 1818 20 pp  
 Dr Shippen of Philadelphia father of Professor Shippen By his grand-daughter Med Repository 1902 v 355  
 American Medical Biography By JAMES THACHER Boston 1830 Article on William Shippen Junior u p 82



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#### REFERENCES

- Eulogium on William Shippen M.D. By CASPER WISTAR M.D. Phila. J. M. & Phys. Sc. 1822 v 173  
 Professor Morgan. Retrospective Review. North American M. & S. J. 1827 iv 362  
 John Morgan. By M. I. WILBERT. Am. J. Pharm. 1904 Jan. 1  
 William Shippen Jun. By JAMES EVELAN PILCHER. J. Ass. Mil. Surg. 1904 xiv 61  
 Callwell Charles. Eulogium of William Shippen. Philadelphia 1818 20 pp.  
 Dr Shippen of Philadelphia father of Professor Shippen. By his grand-daughter. Med. Repository 1902 v 355  
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# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN M.D., F.A.C.S. OMAHA, NEBRASKA

### CÆLIUS AURELIANUS

ORIGINALITY or at least some difference with or progress beyond accepted methods and beliefs is necessary to accomplish reputation for any individual and make that individual an outstanding figure. Cælius Aurelianus chose for his life work a profession which at his time was dominated and had been dominated for more than a century by the teachings of Claudius Galen. To him there were open three opportunities. Either to become a follower of the Galenic doctrines of eclecticism and sink into the level of mediocrity by becoming an infinitesimal grain of sand in a great mass or to adopt one or another type of the numerous forms of charlatanism of the period and lose his self respect if not his originality, or to find some other outlet for his mental effort and so how out a career for himself which would permit him some autonomy and also allow him to achieve some reputation for himself. Of the three openings Aurelianus chose the latter and solved his problem by becoming a follower of the greatest competitor of Galen, Soranus of Ephesus. Incidentally he preserved for us some of the work of Soranus and gave us in his work one of the best descriptions of the beliefs and practices of the sect of the Methodists which had been founded by Asclepiades of Prusa in the first century B.C., changed, not particularly for its benefit by Themison a little later in the same century continued by Soranus at about the time of Galen and then overshadowed by the popularity of the Galenic school.

Cælius Aurelianus was an African, born at Sicca in Numidia who lived about the end of the third and beginning of the fourth century A.D. He came to Rome and there practiced and taught medicine and surgery and achieved a considerable reputation both from his writings and his success in practice. His work became one of the principal guides followed by the medieval monks and is the principal authority that we now have for the views and principles of the Methodist school as it existed during the closing years of the Roman period.

It was not until well along in the sixteenth century 1529 that Aurelianus' work was printed and then only in part. In that year the *Five Books of Chronic Diseases* was published in folio at Basle by Henricus Petrus. Four years later in 1533 the *Three Books of Acute Diseases* was printed in Paris by Simon de Colines of the Stephanus Press the step father of Robert Estienne. Fourteen years later

Aldus included the *Five Books of Chronic Diseases* in the Aldine medical collection which appeared in 1547 under the title *Medici Antiqui Omnes The Acute and Chronic Diseases* was published in one volume for the first time in 1567 and again in 1569 at Leyden by William Rovillius. These editions evidently supplied the demand for more than a century and it was not until 1709 that a Swiss physician, residing in Holland, Johann Conrad Amman, brought out a new and most complete edition of the works of that author. Amman is noted also for his work on the education of the deaf and in 1691 he published a treatise on this subject which was written in Latin and achieved such a reputation that it was translated into Dutch and English.

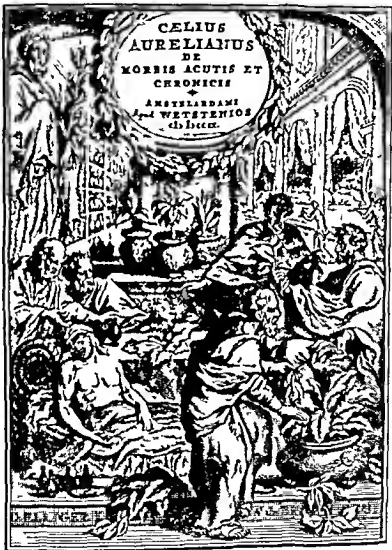
This work of Cælius Aurelianus is practically the only one which gives the ideas and teachings of the Methodist school as it is frankly a translation into Latin of the work of Soranus of Ephesus which has in great part been lost in the original. Aurelianus was an African consequently his Latin is not particularly good and the book is by no means a model, but in spite of these drawbacks it is important for its historical value and the fact that even as late as the Salernitan School it held its position almost on a par with the works of Hippocrates and Galen when they were read and taught to the students of medicine. Thus the three great schools—Dogmatic, Eclectic, and Methodist—were represented by these three authors in the teaching of the middle ages.

The greater part of the work deals with internal medicine and contains much pharmacology together with baths, enemata, and other therapeutic devices used in that form of practice. He does however occasionally advise surgical procedure such as tracheotomy which he refers back to Asclepiades but that he is not very enthusiastic about operative procedures may be gathered from his description of hernia. He speaks of cases in which the hernia goes into the scrotum and apparently becomes strangulated. For this he advises the attempted replacement by various means and finally says that the sac may be opened and replacement carried out by "audacissima chirurgia" (most audacious surgery).

In the field of descriptive symptomatology of disease the work is good. The description of hydrophobia is both exhaustive and excellent and the same may be said of many other diseases. One concludes from the book that Soranus was a clear and accurate observer and that at the least Aurelianus did a great service in preserving his work.

CELIUS  
AURELIANUS  
DE  
MORBIS ACUTIS ET  
CHRONICIS

AMSTELÆDAMI  
Apud WETSTENIOS  
Librarios.



Chemotherapy is of no value, moreover it may produce harm. Vaccine therapy is of value only in gonorrhoeal complications such as prostatitis, epididymitis, and arthritis. Diathermy has proved very unsatisfactory even though the literature gives it much credit especially in epididymitis. Small incisions for suppurating inguinal adenitis are best. Cocaine of any strength is dangerous and given no place in genito urinary surgery.

Strictures are carefully dilated to No 32F and No 35F sounds. The chapter on strictures is very comprehensive and complete.

It is stated that gonorrhoeal patients who develop an arthritis are not predisposed to arthritis in their next attack of neisserian urethritis. In the treatment of arthritis typhoid vaccine is used intravenously. The authors do not consider salicylates of value in gonorrhoeal arthritis and believe that this is one way to differentiate gonorrhoeal arthritis from other arthritides.

The urethra is the site of infection in non parous women and the cervix in parous women. Six to 8 per cent silver nitrate is used without hesitancy on the acutely infected cervix. Non operative procedures are stressed in the treatment of salpingitis.

The criteria of cure of female gonorrhoea are normal appearing Bartholin's glands, urethra, para urethral crypts, vagina, cervix, and anus. A bimanual examination must exclude pathology in uterus and tubes. Smears are taken from a massaged dilated urethra after treatment with silver nitrate. The urine is centrifuged and stained. Smears are also taken from Bartholin's glands, Skene's tubules, the cervix (before and after menses), and the anus. These tests are repeated in 2, 4, and 6 months. If all tests are negative at the end of a year marriage is permitted.

Government education of the people in matters of venereal diseases is advocated.

This book is interesting reading and is quite valuable in that it gives us the ideas of men whose experience has been wide and varied. HARRY CULVER

EVER since the first installments of *Biology and Pathology of Woman* put in appearance in 1913 I have promised myself the pleasure of presenting to the readers of *SURGERY, GYNECOLOGY and OBSTETRICS* an appraisal of this stupendous undertaking in its entirety. After less than six years—a short time, indeed for so gigantic an enterprise—the monumental work is now before us complete. Its fifteen volumes of large format, each of about one thousand pages, represent an encyclopædia of unprecedented proportions and one's amazement at such 11 is still more intensified as one finds that the index covers no fewer than 109 pages, and that the table of contents alone occupies 58 pages.

This table of contents permits a clear insight into the plan of the work.

BIOLOGIE UND PATHOLOGIE DES WEIBES. EIN HANDBUCH DER FRAUENHEILKUNDE UND GEBURTSHILFE. Edited by Prof. Dr. Josef Hildebrand. Vol. 1, 1. Prof. Dr. Ludwig Seitz, 2. Frankfurt, Berlin and Vienna. 1. Ban & Schwarzenberg 1921 to 1929.

The first volume contains chapters on the history of gynecology, normal embryology, anatomy, histology, topography, and physiology of the female urogenital tract, comparative anatomy and physiology of these organs in domesticated and experimental animals, endocrinology, eugenics, hygiene, and occupational diseases. The second volume deals with general symptomatology and diagnosis, methods of examination, medicinal and organotherapy, protein therapy, X-ray and radium treatment, psychotherapy, preoperative and postoperative treatment, general and local anesthesia. The third volume covers the problem of constitution, disturbances of growth, osteomalacia, chlorosis, malformations, malpositions, sterility, sterilization, pathology of menstruation, bacteriology of the vagina, diseases of vulva and vagina. In the fourth volume we read of inflammations, atrophy and hypertrophy of uterus and cervix, disturbances of secretion, hemorrhages, pathology and treatment of fibroids, cancers, and all other tumors of the uterus. The fifth volume takes up tumors of the tubes, diseases of the pelvic peritoneum, ligaments, nerves and blood vessels, further, actinomycosis, tuberculosis and syphilis of the genitals. In the sixth volume tumors of the ovaries and their treatment are discussed, likewise injuries of, and foreign bodies in the genitals, peritonitis and diseases of the breasts. The seventh volume is devoted to psychology and psychiatry in gynecology, the interrelations between the female genitals and ear, nose and throat, musculature and bones, digestive, circulatory, and hæmopoietic systems, eye and skin, liver and kidneys, and finally, discusses the sedimentation test. The eighth volume treats of the relationship to infectious and respiratory disorders, metabolism, adrenals, spleen and pancreas, urinary organs and nervous system, and contains an essay on the physiology and pathology of puberty.

Beginning with the ninth volume, obstetrical subjects are presented. Here we find chapters on the development of the ovum and placenta, anatomy and physiology of the fetus, physiology and pathology of placenta and amniotic fluid. The tenth volume covers the pathology of decidua, membranes and umbilical cord, biochemistry of pregnancy and parturition, physiology and diagnosis of pregnancy, and uterine contractions. Normal childbirth, multiple pregnancy, abnormal duration of gestation, premature birth and abortion, and toxæmias are discussed in volume eleven. The twelfth volume deals with anomalies of passage and passenger, mole and chorioepithelioma and ectopic pregnancy. In the thirteenth volume are presented placenta prævia, the third stage, puerperium, uterine rupture, operations during pregnancy, and sudden death in pregnancy, labor and puerperium. The fourteenth volume is given over to operative obstetrics and the physiology and pathology of the newborn. The final volume rounds out the work by chapters on normal and pathological parturition in domestic animals, medicolegal gynecology, achievements of gynecology

## REVIEWS OF NEW BOOKS

**T**HE subtitle of the new contribution on *Progressive Relaxation*<sup>1</sup> is "A Physiological and Clinical Investigation of Muscular States and their Significance in Psychology and Medical Practice." This is the product of twenty years' work and comes from the physiological laboratory of the University of Chicago. It is a most scholarly and scientific presentation and review of existing knowledge and contains the carefully developed argument for a new approach to 'nervousness' together with exact details of the author's technique of treatment.

The book contains eighteen chapters with an extensive bibliography and index. The author first calls attention to the hitherto lack of exact physiological knowledge of rest and relaxation. He defines neuromuscular or nervous hypertension as "a condition marked by reflex phenomena of hyperexcitation and hyperirritation." He suggests that the term 'nervous hypertension' should largely replace the term 'neurasthenia.' He believes that in most instances the exhaustion implied in neurasthenia is a byproduct of tension. The appearance of phenomena of nervous hypertension in various diseases throughout the whole range of medicine and surgery is well discussed. The extreme degree of relaxation required for success is termed 'progressive relaxation.' 'Differential relaxation' is the absence of an undue degree of contraction in the muscles employed for an act while other muscles not so needed remain flaccid. Sixty pages are devoted to the technique of inducing these states. Chapters on the influence of relaxation upon the reflex reaction to sudden pain upon the knee jerk and upon mental activities though models of careful scientific work are highly technical and difficult for any but workers in physiology. There is a similarly excellent discussion of tonus. A special chapter is devoted to the application of the author's method in spastic oropharynx and mucous colitis. Illustrative cases in diverse medical conditions and the therapeutic use of progressive relaxation complete this volume.

The neurologist or psychiatrist with adequate clinical experience in neuroses will be surprised at the complete and consistent absence of the psychotherapeutic viewpoint. Dr. Jacobson has even gone to great care to avoid any effects explainable by suggestion. It is argued that during neurosis there is failure to relax. Recovery by whatever route attained generally is characterized by a return to a fairly normal relaxed state. The various methods to this end heretofore have been indirect in the measures employed perhaps because the importance of physiological relaxation has not been fully realized. To the reviewer there appears to be a question of priority. Granted some distressing experience

leading to emotional disturbance such as a fear which is built on certain misinterpretations there will be neuromuscular tension. This in turn will send to the brain proprioceptive impulses which in turn will increase the tension and a vicious circle of habitual state will result. Where is the chief offender in this vicious circle? Alteration of mental content, attitude or viewpoint often results in lowered tension. It is impossible to conceive that any alteration of tension can correct misinterpretations or banish fears based thereon. Taken as an independent method of treatment Dr. Jacobson's contribution challenges the whole mental hygiene position. Taken as an adjunct in re-education, new habit formation and better physical hygiene after psychic data are adjusted, it is full of promise of great value.

JOHN FANTILL.

**T**HE authors of *Gonorrhea and Kindred Affections*<sup>2</sup> have endeavored to produce a short and practical work to be used by both the specialist and the general practitioner. A short concise history of gonorrhea is given and a plea is made for checking the incidence of gonorrhea by teaching how the proper respect for women and themselves but prophylaxis and regular medical examination of prostitutes are not stressed. Even though the American and foreign authors are paying less and less attention to the complement fixation test it has a certain definite value and should be used. The statement that an absolute immunity is gained from an attack of gonorrhea and that 90 per cent of the cases of gonorrhea becomes posterior even with the best of care may be somewhat explained by the fact that the author uses the sealed in treatment for early anterior urethritis. Posterior urethritis he believes does best when the methods of treatment and the solutions used are changed from time to time. He advocates that when massaging a prostate it is best to pass the finger to the limit of the right or left lobe of the prostate and massage outward and downward never from side to side across the urethra. The criteria for the cure of gonorrhea in the male should be nine gonorrhea free smears and cultures of the urethra following massage, sound, vaccine and silver nitrate. In addition to this the patient is urethroscopied and the urine cultured. This is all repeated after a week's rest and again after a two weeks' rest. A complement fixation test is done last. The author states that he has not seen the disappearance of gonococci in patients after attacks of high fever. He furthermore believes that the gonococcus remains many years in the epididymis after it has once been attacked.

1. *PROGRESSIVE RELAXATION: A PHYSIOLOGICAL AND CLINICAL INVESTIGATION OF MUSCULAR STATES AND THEIR SIGNIFICANCE IN PSYCHOLOGY AND MEDICAL PRACTICE.* By Edmund Jacobson, A.M., Ph.D., M.D. Chicago: University of Chicago Press, 1929.

2. *GYNECOLOGY AND OBSTETRICS. GONORRHEA IN THE MALE.* CRANFORD AND VERRUCA ACQUINATA. By George Robertson, A.B., M.D., F.A.C.S. GONORRHEA IN THE FEMALE. AND THE INFECTIOUS GRANULOMATA. By Edward Atwell Schuchard, A.B., M.D., F.A.C.S. New York and London: D. Appleton and Company, 1929.

From all that has been said, it is quite clear that the many thousands of scientific gynecologists in this country and the world over simply have to have this work, and that without it no public medical library can hope to be complete.

GEORGE GELLHORN

IN recent years a number of manuals dealing with the subject of electrocardiography have been published. Among these the book of Dr Wiggers<sup>1</sup> will take high rank. The author has had precisely the experience to which he modestly lays claim, experience in the use of the electrocardiograph in experimental work and in the clinic and is thoroughly familiar with the physical principles upon which the electrocardiograph has been developed. The early chapters of the book are concerned with the physics both electrical and optical of electrocardiography—these are followed by descriptions of the various types of instruments upon the market. The second part is opened with a description of the normal electrocardiogram following which the significance of the deflections is discussed. Indeed the chapters on 'The Significance of Electrical Deflections' contain within a brief compass a comprehensive survey of fundamental principles in the interpretation of electrocardiograms. The remaining sections are given over to the presentation of the clinical aspects of electrocardiography. In the preface the author states that the plan of instruction used in his courses in the medical schools with which he has been connected has been evolved as a basis for the book. In fact a large part was actually written while the practical courses were in progress. This has given to the clinical sections a didactic quality which does not make for the pleasure of reading but it will serve to make it easy for the beginner to retain what he reads which after all is the aim of the author. The book ought to be well received. It is of real value. If there is any criticism to be offered it would be to suggest that another edition may well contain more illustrative electrocardiograms. The clinical sections might be amplified with a wider range of electrocardiograms and thus be of more help to the man who is working out his electrocardiographic problems alone.

JAMES G CARR

THE two volume set on *Otosclerosis*<sup>2</sup> is published under the auspices of the scientific committee of the American Otological Society and represents the first step in an extensive study of the problem of otosclerosis. It comprises about 500 pages divided into four sections dealing with pathology, etiology, symptoms and diagnosis and treatment. A very exhaustive study has been made of the history and research in

this type of deafness. The book is not intended as a text on otology but is a comprehensive review of all available literature to date on otosclerosis. It contains a most extensive bibliography in addition to an author index. It is probably the greatest reference work on otosclerosis to date. JOHN F DELPHE

IN the foreword of the book entitled *Radium Treatment of Cancer*<sup>3</sup> the author states that the work covers a period of 5 years and embodies the experience of the staff of the Westminster Hospital which includes nine of his colleagues.

The divisions of the volume are well organized and include a clear and concise explanation of the physics of radium, the general principles of treatment, the technique involved in the application of the doses advocated by the authors and illustrative cases of the treatment of the most common sites of malignant disease.

The chapters on cancer of the buccal cavity and on the breast will be especially interesting to the general surgeon. In cases of oral cancer the author states that radium therapy of the primary growth should always be the first step in the treatment and that surgery should not be directed against the lesion unless the treatment fails.

There has long been a controversy both here and abroad over the amount of radium to be used in a given case. At the present time some of our largest centers are using great amounts for a short period of time and are thus delivering 'gram' doses. At the Westminster Hospital they rely upon small amounts of radium with long time exposures and the results they have obtained constitute, in my opinion, a strong argument in favor of their method.

The book is well illustrated and in addition contains 13 colored plates which are excellently done. The chapter on skin covers less than two and one half pages and might well be enlarged. On the whole it is a very good exposition of the subject and I believe it furnishes a valuable and timely link between the surgeon and radium therapist.

R C CRAIN

THE book on *Physical Therapeutic Technique*<sup>4</sup> by Dr Granger who was the best known authority on physical therapy in the United States is the best of its kind that has appeared. It is not for the specialist in physical therapy but is intended for the physician who has installed a limited equipment. Therefore there are rather sketchy chapters on mechanotherapy, muscle re-education and massage. This is the only serious fault in the book for the physician using physical therapy should know the technique of muscle re-education.

The first one hundred pages give an excellent description of the use of electrotherapy with some fundamentals of the physics of the various currents.

<sup>1</sup>RADIIUM TREATMENT OF CANCER. By Stanford Cade F.R.C.S. (Eng.) New York: William Wood and Company 1929.

<sup>2</sup>PHYSICAL THERAPEUTIC TECHNIQUE. By Frank B. Granger A.B. M.D. With a foreword by Willam D. McFee M.D. Philadelphia and London: W. B. Saunders Company 1929.

<sup>1</sup>PRINCIPLES AND PRACTICE OF ELECTROCARDIOGRAPHY. By Carl J. Wiggers M.D. St. Louis: The C. V. Mosby Company 1929.

<sup>2</sup>OTOSCLEROSIS: A REVIEW OF THE LITERATURE TO JULY 1925. Compiled under the direction of the committee on otosclerosis, American Otological Society. By Norval H. Perce, M.D.; J. M. E. McKernon M.D.; F. A. Cockett, M.D.; J. Gordon Wilson M.D.; and Arthur B. Duell M.D. Editor. Vols. I and II. New York: Paul B. Hoeber Inc. 1929.



in the nineteenth century the reticulo epithelial system in woman, vitamins, fever in labor and the effect of premature rupture of the membranes on childbirth.

Of this truly imposing array of contributions I have reported many at some detail in numerous previous reviews. Each chapter is a complete essay on the respective subject, some of them represent veritable monographs. To select a few at random the chapter on medicinal treatment covers 140 pages; that on sterility 164 pages; the two chapters on ovarian tumors have 353 pages; the essay on abortion numbers 240 and the treatise on gynecologic urology 353 pages. The thoroughness of presentation is further attested by thousands upon thousands of bibliographic references appended in smallest print at the end of each chapter. American literature is well represented except for the years during and immediately after the war when the impoverished condition of the country made our journals inaccessible to German writers.

Ninety-four collaborators have contributed to the work. Almost all of these are men known to the medical world as authorities on the particular subjects they have discussed. Internists and neuro-psychiatrists, dermatologists and historians, oculists and veterinarians have labored side by side with gynecologists to make this undertaking complete from every aspect and it may be said without exaggeration that no better proof of scientific solidarity and co-operation could have been given. That not all the essays and chapters are of equal standard is after all only natural with so large a number of collaborators. A certain amount of overlapping and repetition was unavoidable and seems to me even desirable if the various subjects were to be viewed from every possible angle. Neither should it be a matter of criticism if here and there we find opinions expressed which may not be acceptable to everyone for medicine is no exact science but remains forever in a state of flux and many of the newer teachings are still debatable while even the older and seemingly established ones are always subject to changes. But it would be quibbling to pick flaws in a work which has given to the medical world an entirely new conception of gynecology.

We have traveled far in the last sixty or seventy years since our young specialty first began to struggle into a place of its own and aspire to independence by the side of its parents, Obstetrics and Surgery. Then and for many years to come attention was focused on local changes within the reproductive sphere and our therapy consisted altogether of local treatment by means of medicines or the knife. The last two decades have brought about a decided change. Serology and bacteriology, physiology and endocrinology, the study of heredity and constitution, the recognition of the effect of occupation and the evaluation of psychic influences—all these have widened our gynecologic horizon and enabled us to realize that our endeavors must not be limited to a certain set of organs but should embrace as well

the organism which harbors these organs. If we only had a more comprehensive term for this new gynecology in the English language! The Germans have progressed from *Frauenheilkunde* to *Frauenkunde*. To create a work which should collect the entire material and present all the available facts in a clear and consistent manner that has been the plan of the editors. To quote their own words in the preface: "the work not only describes the diseases of the female generative organs but also assembles everything that may have a bearing on the origin and treatment of these diseases from the moment of conception to the grave. Such a work therefore must extend its scope beyond that of all previous handbooks in our specialty."

*Biology and Pathology of Woman* serves a double purpose. To the active specialist it is an authoritative guide to the researcher a reference work on all developments to the present day. We now understand the reason why chapters on comparative anatomy, physiology and pathology of animals are included. Not only is much of our fundamental knowledge derived from observations and experiments on animals but the detailed description of methods of experimentation saves a good deal of time for those who wish to engage in similar investigations.

For practical purposes the proposition amounts to this: Whoever embarks on any clinical or experimental study or research on any gynecological or obstetrical subject will hereafter consult first the respective chapter or chapters in this handbook. For reasons previously stated he may have to look up the American literature from 1914 to 1923 and will then be ready to start on his own work.

I have not yet mentioned the illustrations. There is an almost endless number of them, many of which have never before been published and there is a profusion of color plates of unsurpassed excellence. When one realizes that this work was conceived of and carried into effect at the time of greatest post war depletion and depression in Germany, the vision, daring and determination of the editors and publishers excites our sincere admiration. We thank them for what they have given us and we congratulate them on their success in creating a work of which it is difficult to speak in other than superlative terms.

Such a work must not become obsolete. Yet experience has demonstrated that the most extensive reference works all too soon become antiquated. I mention merely the handbooks by Wackel and by Vent and it seems that medical evolution takes on more rapid strides than ever before. We trust that the publishers of *Biology and Pathology of Woman* have devised a way to avoid such an issue in this case. Perhaps our own loose leaf systems and monographic collections with their appendices brought out every few years may suggest a way by which this work can always be kept abreast of any progress made and thus be retained as an evergreen classic of gynecologic literature.

7

The technique here is well explained and well illustrated.

The value of massage is stressed and Granger makes a plea that as soon as the physician needs an assistant or a technician the common practice of training an office secretary be abandoned and a person trained in massage and muscle re-education be secured.

There is an excellent chapter on a hospital department of physical therapy, giving suggested lists of equipment and floor plans.

The last two hundred and twenty-five pages are devoted to the technique of physical therapy in various pathological conditions. Here it is emphasized that physical therapy is only an adjunct that it should be prescribed only after a careful physical examination has been made that etiological factors should first be sought and eliminated and that proper medical and surgical procedures should go hand in hand with physical therapy. This is based on twenty-five years' experience in a large private practice devoted to physical therapy and as director of one of the largest hospital physical therapy departments in the world.

This book will be a great help to the beginner and of great interest to those familiar with physical therapy.

J S C

GUTZEIT'S monograph<sup>1</sup> is a rather complete discussion of the development and the uses, advantages and disadvantages of the method of gastroscopy for diagnostic purposes. He has made over 500 gastroscopic examinations and gives the reviewer the impression of having mastered this rather difficult procedure. He gives explicit directions and valuable suggestions for successful carrying out of the method. Though an enthusiast on the subject he frankly admits the disadvantages of the method. Among them he mentions sensitive throat difficulty in passing a rigid instrument, possible damage to the oesophagus and perforation of the stomach wall with the instrument. The damage to the oesophagus is particularly to be feared because of great difficulty of approach and repair. The author also states that not all of the gastric area is accessible to view. The lesser curvature and the area of the pyloric portion cannot be brought into the view. Its greatest advantage is in the recognition of a gastritis. So far as ulcer and carcinoma are concerned the roentgen ray study will always give more reliable information. The method will in all probability find very little favor this side of the Atlantic.

GEORGE HALPERIN

<sup>1</sup>Die GASTROSKOPIE IM RAHMEN DER KLINISCHEN MAGEN-DEAGNOSTIK. By Dr. Kurt Gutzeit. Berlin: Julius Springer 1929.

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

CRANIAL RAY THERAPY. By Gustav Bucky, M.D. With Contributions by Dr. Otto Glasser and Dr. Olga Bickel. Manheimer. Translated by Walter James Highman, M.D. New York: The Macmillan Company, 1929.

TRADE PRACTICE CONFERENCES. Federal Trade Commission. Washington: U.S. Government Printing Office, 1929.

THE ADRENALS: THEIR PHYSIOLOGY, PATHOLOGY AND DISEASES. By Max A. Goldzieher, M.D. New York: The Macmillan Company, 1929.

METHODS AND PROBLEMS OF MEDICAL EDUCATION. 15th Series. New York: The Rockefeller Foundation, 1929.

THE NERVOUS CHILD. By Hector Charles Cameron, M.A., M.D. (Cantab.), F.R.C.P. (Lond.). 4th ed. New York and London: Oxford University Press, 1929.

TESTICULAR GRAFTING FROM APE TO MAN. OPERATIVE TECHNIQUE. PHYSIOLOGICAL MANIFESTATIONS. HISTOLOGICAL EVOLUTION. SYMPTOMS. By Serge Voronoff and George Alexandrescu. Translated by Theodore C. Merrill, M.D. London: Brentano's Ltd., 1929.

AIMS TO ORTHOPEDIC SURGERY. By Eric A. Crook, M.Ch. (Oxon.), F.R.C.S. (Eng.). New York: William Wood and Company, 1929.

LIBRE JUBILAIRE DU PROFESSEUR JEAN VERHOEGEN. Bruxelles: L'Imprimerie Lefens, 1929.

A MANUAL OF MIDWIFERY FOR STUDENTS AND PRACTITIONERS. By Henry Jellett, B.A., M.D. (Dub. Univ.), F.R.C.P.I., L.M., and David G. Madill, B.A., M.B., B.Ch., B.A.O. (Dub. Univ.), L.M., 4th ed. New York: William Wood and Company, 1929.

SYNOPSIS OF THE PRACTICE OF PREVENTIVE MEDICINE AS APPLIED IN THE BASIC MEDICAL SCIENCES AND CLINICAL INSTRUCTION AT THE HARVARD MEDICAL SCHOOL. Cambridge: Harvard University Press, 1929.

THE TREATMENT OF THE COMMON DISORDERS OF DIGESTION: A HANDBOOK FOR PHYSICIANS AND STUDENTS. By John L. Kantor, Ph.D., M.D., 2d ed. St. Louis: The C.V. Mosby Company, 1929.

AN OUTLINE OF NEUROLOGY AND ITS OUTLOOK. By Sir E. Farquhar Buzzard, K.C.V.O., M.A., M.D., F.R.C.P. Being the Eleventh Earl Grey Memorial Lecture Delivered at King's Hall, Armstrong College, Newcastle-on-Tyne, March 11, 1929. London: Oxford University Press, 1929.

THE VALUE OF THE BLOOD AND PLASMA IN HEALTH AND DISEASE. By Leonard G. Rowntree, M.D., and George E. Brown, M.D. With the Technical Assistance of Grace M. Roth. Philadelphia and London: W.B. Saunders Company, 1929.

LA PERNÉABILITÉ ET LES OBSTRUCTIONS TUBAIRES. STÉRILITÉ—INFECTIONS. SALPINGIENNES. CHIRURGIE TUBAIRE. By Claude Bérthe. Preface by Professeur P. Lecène. Paris: Masson et Cie, 1929.

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME L

JANUARY, 1930

NUMBER 1A

## SOME PRINCIPLES IN ABDOMINAL SURGERY<sup>1</sup>

D P D WILKIE MD FRCS FACS EDINBURGH SCOTLAND

IT is but fitting at the opening night of our annual meeting that we should pause for a few minutes to do reverence and honor to the memory of America's greatest teacher and Chicago's master surgeon. Here we have the environment, the atmosphere which played so great a part in the making of Murphy, for in him was personified the intensive energy of this great city of the Middle West. He grew with it, he gloried in it, in his work and in his teaching there was ever the thrill and the romance of the pioneer. The boundless energy of the growing West was in his blood and into surgery he brought that dynamic force and zeal which were in keeping with the eager and restless activities around him. Pre eminently at this meeting, held in the arena where for so long he was the leading figure, we recall with gratitude his gifts and his achievements.

The opening years of this century will be remembered as those in which American surgery as a science and as an art made its full advance into the front rank of world medicine. Prominent among the names in that band of gifted men who put surgery in America on the sure and safe footing which it enjoys today, will be that of J. B. Murphy in whose unique personality enterprise and enthusiasm were so happily and so effectively combined. Murphy, for many years before his untimely death had attained to the full stature of a surgeon. Foremost among his many surgical virtues was a true scientific imagination. This, combined with his tremendous concentration on the sub-

ject in hand, led to his many remarkable contributions to surgical knowledge. He saw things clearly and had the power of presenting them in vivid relief, so that by convincing argument he led on to conclusions which seemed inevitable and irresistible. He will always be remembered as the foremost among clinical teachers and chiefly because of the fact that while no man could equal him in the intensity of his focused attention on the individual case, few, if any, could surpass him in drawing the moral and laying bare the underlying principles which the case displayed. About Murphy there was nothing small or parochial, he was a world teacher and an idealist. In the inauguration of this great Clinical Congress and the founding of the American College of Surgeons he played a leading part, and tonight it is especially appropriate that we should remember him at home as a founder of our College in the city of which he was so honored a citizen and surgeon.

American surgery has for many years had an outstanding characteristic: it has been catholic in its grasp, international in its basis. In the search for fresh knowledge, the acquisition of new methods or technique by first hand observation at the source, Murphy by precept and by practice led the way. The international exchange of ideas which he fostered is now one of the most valuable and wholesome features of our profession, promoting as it does not only a high general standard of efficiency, but that mutual understanding and

<sup>1</sup>The John B. Murphy Oration in Surgery delivered at the Clinical Congress of the American College of Surgeons at Chicago, October 14, 1929.



*W. L. Leland*

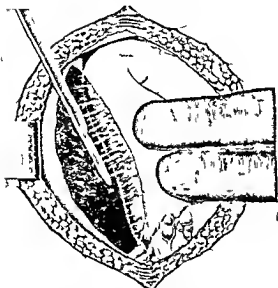


Fig. 1 Mobilization of the duodenum division of fascia propria along its outer border

#### THE PRINCIPLE OF DE TENSION

It is in the effective mobilization of the tissues to be dealt with that our text is best illustrated. Deal only with the mobile organ, if it be immobile, mobilize it. Do it not by force but by strategy based on the anatomical fact that all the abdominal organs were mobile before some became fixed, and therefore all may again be rendered mobile. This sounds dangerously like a platitude, and yet this rule is but imperfectly observed and what should be easy and safe surgery is often rendered difficult for the surgeon and dangerous for the patient.

When William Mayo demonstrated so beautifully how a generous mobilization of the proximal colon might be effected so as to render resection of a large segment both simple and safe, he illustrated a principle which has a widespread application in the abdomen. Other portions of the gut, such as the duodenum, the splenic flexure, and the descending and iliac portions of the colon, are equally susceptible of mobilization. How often can a resection of the transverse or distal parts of the colon be rendered easy by a simple division of the phrenicocolic ligament, enabling tissues, which would otherwise be united under tension, that unforgivable sin in abdominal surgery, to fall

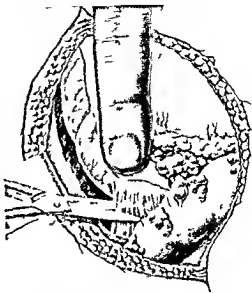


Fig. 2 Division of fascia propria at the angle to insure free mobilization of the duodenum

together in perfect relaxation. In the mobilization of organs there are two structures to be divided: the peritoneal folds which retain them and the underlying—in the case of diseased organs, usually thickened—extraperitoneal cellular tissue or, as we usually designate it, the “fascia propria.” It is the division of this fascial layer which renders the mobilization complete, and this division can best be effected by the knife (Fig. 1). Thus we find, in the mobilization of the duodenum, that a simple division of the peritoneum along its lateral border will free it considerably, but it is only when we divide the fascial bands which hold it, and especially its inferior border, that it can be brought up freely into the abdominal wound (Fig. 2). In the case of the colon the systematic division of the extraperitoneal fascial bands by the knife is of equal advantage.

In one operation above all others, however, is this principle seen to greatest advantage, namely in splenectomy. The greatest impediment to removal of the enlarged spleen is in my experience not inflammatory adhesions, which are rare, but the short outer leaf of the lienorenal ligament. Without an adequate severance of the ligament, the spleen cannot be delivered except at the imminent risk of a tear in the hilum. Not only must the peritoneum

friendship which make for peace among the nations

It is a peculiar honor to deliver the Oration in his memory. That you should have asked a surgeon from Scotland is evidence of the bond which unites our profession in every land, and the special ties which bind my homeland to your great country. That you chose a surgeon from Edinburgh was a graceful tribute to the long standing and fruitful connection of the great University which I represent with American medicine. When we recall that John Morgan, the pioneer of medical education in America studied in Edinburgh that William Shippen, who with Morgan started the first medical school in America, was a graduate of Edinburgh in 1761, that Philip Syng Physick, the father of American surgery, took his M.D. at Edinburgh in 1797, that Benjamin Rush the most distinguished physician of his day and a name still held in reverence among you, was an Edinburgh graduate in 1768, that Samuel Bard who started the first medical school in New York in 1769, had taken his degree in Edinburgh but 4 years before that William Gibson, the founder of the University of Maryland, was a pupil of Sir Charles Hell and an Edinburgh graduate, that Ephraim MacDowell that fearless practitioner and pioneer of abdominal surgery, got his idea and inspiration when studying under John HELL in Edinburgh—when we recall these indissoluble bonds which united early American medicine with the Scottish capital, you may truly claim Edinburgh as your Alma Mater and I am proud as her representative to be among you today.

In choosing a subject for this address I was influenced by the fact that, while Murphy in his eager course roamed over the whole field of surgery, his earlier, and perhaps his most valuable contributions were in the domain of the abdomen. It will not, therefore I trust be altogether unfitting that I should draw your attention to some principles which I believe are fundamental in abdominal surgery. If many of you recognize in what I say the old familiar faces of the well known facts you will pardon the re introduction.

The capacity of the peritoneum and the abdominal viscera to tolerate even gross inter-

ference has been fully tested during the past 50 years and has formed the basis and the backbone of modern surgery. So great is that tolerance that we as surgeons are apt to presume on it and to lose that sense of reverence for living tissues which should be a fundamental law in operative surgery. By an elaborate ritual we endeavor to insure that our operations shall be aseptic but ritual without reverence may be a mockery and technique associated with trauma will be tolerated less well than much less perfect asepsis but gentle handling. If we had to epitomize our guiding rules in the surgery of the abdomen, I believe that we might correctly do so by stating "no traction no tension." The primary impression conveyed to the mind at the first sight of the interior of a normal abdomen is the remarkable flaccidity of all the hollow viscera, in quietness and in relaxation lies their strength. When disease or operative measures interfere with this relaxation and introduce tension trouble and pain result. Our guiding principle thus will be to relieve tension when we find it and so to plan our operative work that neither during nor after the operation shall tension on the abdominal wall, the viscera, or the mesenteries be present.

The signal advance in our standard of pre operative diagnosis has furnished us with the advantage of being able so to plan our incisions in the abdominal wall that we shall have the freest possible access to the seat of disease without recourse to forcible retraction. While the integrity of the abdominal muscles and their nerves will ever command our respect, adequate access must always be the first consideration in any major abdominal operation. Too small incisions beget scars, too small incisions beget complications. If we visualize the tissues as living delicate cellular structures we become less and less intrigued with elaborate mechanical appliances such as powerful self retaining retractors and mighty crushing clamps, instruments which not only injure directly the patient's tissues, but blunt obliquely the surgeon's sensitivity. Retractors should be used to retain out of the surgeon's way tissues which have been gently pushed aside—too often we have seen them used as if they were weapons.

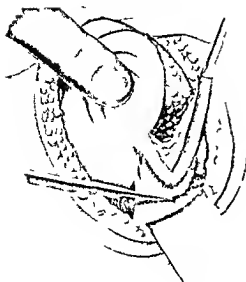


Fig 4 Division of the gastrosesenteric fold—mobilizing the appendix

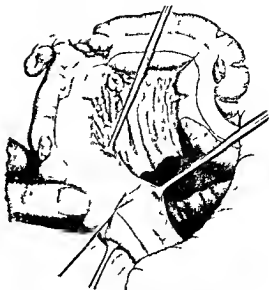


Fig 5 Division of the longitudinal muscular bands as a step in colon resection

appendicostomy or, still better, a valvular tube cæcostomy carried out on the principle of a Scnn's gastrostomy. A colon tube passed *per anum* to beyond the anastomosis is less disturbing but hardly so efficient. Insurance against tension from within by a temporary valvular opening may be practiced with advantage when resection of small intestine for acute obstruction is required, and the upper coils are sodden and dilated. Likewise an ileostomy after a resection of the proximal colon, where a subacute obstruction was present, may make the difference between a smooth and a stormy convalescence and may, indeed, be a life saving measure.

These three elements—mobilization of the viscus, mobilization of its coats, and drainage of its lumen—are best exemplified in a case of resection for a tumor of the descending colon. After free mobilization of the growth has been secured by dividing the peritoneum and fascia propria along the outer side of the distal colon and by cutting the phrenicocolic ligament, the peritoneal and muscular coats are divided round the whole circumference of the gut at the two points chosen for division. Light crushing clamps of the Schoemaker type are then applied at these points and the colon resected. The clamps are then approximated and a pos-

terior row of interrupted fine linen Lembert sutures inserted and tied. An anterior row of similar sutures is now inserted over the clamps which are then removed and the sutures lightly tied, the two ends of intestine coming together without the least tension, and the intramural blood supply suffering a minimum of interruption (Fig 6). Through an incision in the right iliac region a valvular tube cæcostomy is now instituted to obviate any gaseous distention. Such an operation, based as it is throughout on the principle of "de-tension," is followed by singularly little discomfort and in my experience is one of the most satisfactory in the whole field of surgery.

Where, in the case of resection of either small or large intestine, it is deemed wiser to close the cut ends of the bowel and do a lateral anastomosis, the principle of mobilization of coats is still more applicable. A circular incision down to the submucous coat will permit of the application of a catgut ligature and subsequent invagination of a diminutive stump with both rapidity and flaccidity. The cuff method of removing the vermiform appendix is an old and familiar practice. The same method applied to the small and large intestine is sound in principle and easy of performance.





Fig. 3 Mobilization of the spleen. Division of peritoneum and of falciform ligament, the outer leaf of the falciform ligament.

on the outer side of the splenic pedicle be divided but also the underlying fascia (Fig. 3). Thereafter a spleen which was apparently fixed so is almost as easily removed comes forward into a field where easy control of the pedicle is readily secured.

Even when we consider such a simple operation as removal of the vermiform appendix we find that the usual impediment to easy removal is not the presence of inflammatory adhesions but the binding down of the middle third of the organ by that congenital fold first described by Douglas Reid as the genitomesenteric fold. This fold is practically bloodless and a few touches of the knife will divide it and mobilize the appendix completely, thus allowing it to come up without tension into the abdominal wound (Fig. 4).

#### MOBILIZATION OF VISCERAL COATS

When a portion of the gastrointestinal tract is resected, union whether by end to end suture or by lateral anastomosis after closure of the ends, must be effected. When Murphy introduced his button he did a great service to surgery not only by evolving an ingenious instrument which has stood surgeons in good

stead on many occasions when ordinary suture methods were impracticable, but mainly by proving that, if accurate peritoneal apposition was obtained, elaborate layers of suturing were quite unnecessary.

While lest from a suture line may be referable in some cases to sepsis and in others to inadequate blood supply, it is in my opinion usually due to tension either in the long axis of the gut due to inadequate mobilization to tension in the suture line or to postoperative tension within the lumen of the gut. If free mobilization of the ends to be joined has been effected I believe that in the principle of mobilizing the coats of the viscera to be joined so that the layers may be sutured together without any undue tension lies the secret of safe anastomosis. When we remember that the peritoneal and muscular coats of the hollow viscera offer but a slender hold for sutures and that the strength of the wall in every case lies in the submucous coat, we realize that safe approximation of the outer coats can be accomplished only if carried out with these coats completely relaxed. Such relaxation can be secured particularly in the colon, only if these coats are first divided down to the submucous layer in each end of the bowel entering into the anastomosis. In the colon it is the longitudinal muscular bands which, being shorter than the rest of the wall, render uniform relaxation difficult. Consequently division of the bands down to the submucous coat should be an essential step in all colon resections (Fig. 5).

The employment of a single layer of interrupted Lembert sutures lightly tied so as to give the minimum of interference with blood supply is, I believe, the ideal method of anastomosis and the safest if the principle of "de tension" be fully observed. The use of two or more layers of continuous suture drawn tight must inevitably strangle a certain part of the sutured margins and the infected slough so formed will in a few cases determine a leak.

The last form of tension to be feared is tension from within. The evolution and retention of gas in the colon during the first few days after operation may bring about tension necrosis at a suture line otherwise perfect. To insure against this, nothing is so efficient as an

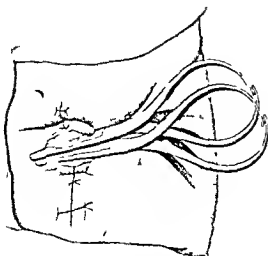


Fig 8 The on-dwelling clamp method of resection of tumor of the lower part of the pelvic colon

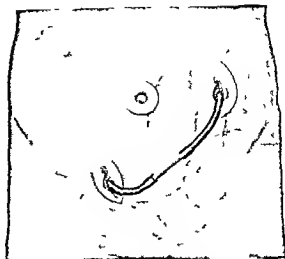


Fig 9 Shadow sketch of tube anastomosis in high obstruction due to peritonitis

The death rate from acute appendicular disease, both in this country and in Britain, has tended to increase rather than to diminish during the past decade. It is my firm conviction that over 90 per cent of the deaths are in cases not of primary inflammation, but of primary obstruction of the appendix with resultant tension, gangrene, and perforation. If we would but visualize this disease as one of the fatal types of acute intestinal obstruction, with the afebrile onset characteristic of such disease, demanding immediate operation before the tense, obstructed organ bursts, if we would teach our students its underlying pathology and demonstrate its characteristic clinical picture—we should not have to deplore a rising death rate from so called appendicitis. Van Zwaluwenburg has, I find, been teaching for more than 25 years the fundamental importance of the obstructive factor in acute appendicular disease. While I cannot agree with him that in all cases obstruction precedes infection, I believe wholeheartedly that blocking of the lumen, with tension, is the real danger in appendicular disease.

#### RELIEF OF TENSION IN ACUTE PERITONITIS

The much discussed problem as to whether drainage of the peritoneum is advantageous and effective in acute diffuse suppurative peri-

tonitis is to my mind answered by this principle, that, in so far as it relieves tension and permits of improved vascularity, it is helpful. Thus in the case of diffuse peritonitis in which, on the opening of the peritoneum, purulent exudate gushes out, tension has obviously been present and a drain will obviate its recurrence. The fact that the drain is very rapidly shut off by intestinal adhesions is undeniable but by that time it has served its purpose. As Murphy showed very clearly, in cases in which drainage is most required, adhesions around the tube form but slowly. We do well to remember his words "Reduction of tension must be initial, and the absence of pressure continuous." The tension may, however, prove to be due not to peritoceal exudate but to intestinal distention. In cases in which this factor is pronounced, benefit will result from a cecostomy or an enterostomy, according to whether the large or small intestine is most affected. Such relief of intra intestinal tension will, among other influences, render a service to the inflamed peritoneum by permitting of more efficient blood supply. In all cases in which cecal distention is a salient feature in the operative findings, a temporary valvular tube cecostomy is invaluable, not only as a safety valve for gas, but as an inlet for fluid to combat dehydration.



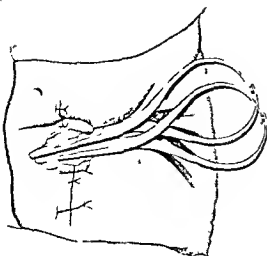


Fig. 8 The on-dwelling clamp method of resection of tumor of the lower part of the pelvic colon

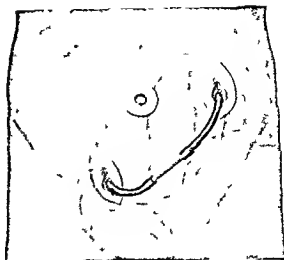


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## THE PRINCIPLE OF COMPLETE ASSAULT

In no other region of the body do we find multiple pathological lesions so frequently as in the abdomen. Such multiple lesions may be associated on a common etiological basis or may to all appearances be present by coincidence. An operation which cures one lesion and leaves behind another unrecognized may have all the stigmata of failure and is apt to bring discredit to surgery. It behooves us therefore, in all abdominal operations, other than those of an emergency character for acute maladies, to be on the lookout for the commonly associated lesions and to exclude other gross pathological changes. I need but refer to the frequently associated lesions in the duodenum, appendix, and gall bladder. It is my belief that all three are dependent on a streptococcal infection and when found together as they not infrequently are, should each be dealt with if a completely satisfactory result is to be assured. Within 1 year I met with a malignant stricture in the colon in 3 cases in which operation was undertaken for long standing gall bladder disease. In one of these, an inadequate exploration failed to reveal the growth which was recognized only when acute obstruction supervened during the convalescence.

Examples might easily be multiplied of dual lesions present at the time of operation and either recognized or missed according to whether the assessment of pathology was thorough or incomplete. The two criteria necessary for such complete assessment if delay and shock are to be avoided, are adequate anesthesia and generous exposure. It is invaluable for future reference that the negative findings should be recorded. This was a characteristic of Murphy's work, and his constant refrain "Let the record show" has been perpetuated as one of the most vital and important rules of the Hospital Standardization scheme of the College.

## THE PRINCIPLE OF THE TWO STAGE OPERATION

In the surgery of the abdomen as in that of many other regions e.g. the brain, the thyroid, and the prostate we have learned that it is frequently not only desirable but well nigh conditional for success, that we proceed by

stages to our ultimate operative goal. Many factors combine to make this surgery by stages a necessity. In abdominal maladies as in few others, the surgeon is often consulted for the first time in the presence of an acute crisis in the disease, e.g., in cases of acute obstruction of the stomach or large intestine, of intense cholemia in obstructive jaundice or of walled off appendicular abscess. The immediate operative indication in any such case is clearly the minimum that will give relief and restore the patient to such condition as will permit of a radical treatment of the causal factor at a later date. The general toxæmia in such cases—the poisoned heart, liver, and kidneys—renders the patient an easy prey to complications if any major procedure is attempted, but further the local conditions are thoroughly unsuitable both for operative work and for satisfactory repair. The tissues in and around the affected area are cedematous and friable, the bowel content frequently putrefying and highly infective, and the lymph channels draining the area laden with bacteria. A preliminary operation, whether it be a gastroenterostomy in a stenosing pyloric carcinoma, a simple choledochostomy in biliary obstruction, a cæcotomy in a large bowel obstruction, or a simple drainage of an appendicular abscess will give the necessary relief and a respite until toxæmia has passed, nutrition is in a measure restored, the factors of local oedema, tension, infected lymph channels, and vascular stasis eliminated and tissue calm restored.

It must be realized that no fixed length of interval between the preliminary and radical operation can be laid down, but that each case presents a problem demanding an individual exercise of surgical judgment. Apart altogether from the benefit accruing to the patient from this restorative interval we know that the mere opening of the abdomen and the handling of the viscera calls forth a reaction which gives to the peritoneum an increased resistance to infection at the second operation. The latter deals with a peritoneum prepared and warned, there has been as it were, a test mobilization of the protective forces.

While working at the subject of peritonitis 20 years ago with the object of testing whether

a specific local immunity could be produced, I was impressed by the fact that the injection of any material whatsoever into the peritoneal cavity gave within 40 hours a markedly increased resistance to a lethal dose of microorganisms. The material injected did not need to be bacterial, it required to be merely foreign material. The same increase in resistance could be secured by a preliminary opening of the abdomen and handling of the viscera. This called forth an immediate emigration of polymorphonuclear leucocytes but later—and more important—a mobilization from the omentum and mesenteries of large macrophages which could “stand to arms” the moment the infection arrived.

When it happens that a resection of some portion of the large bowel constitutes the second operation, an attempt may with advantage be made further to increase the patient's resistance to the possible infection which awaits him. We know that this infection is usually a mixed one—streptococcal and bacillus coli—and by suitable inoculation we may hope to obtain a certain degree of immunity. Since 1909 it has been my custom in all cases of excision of colon or rectum to give two preliminary injections of streptococcus and bacillus coli vaccine, the first given 10 days, the second 3 days before operation, and to combine this with an injection of nucleic acid given 12 hours before the operation, the latter to call forth a leucocytosis. Experimentally I had found that this preliminary treatment gave in animals a definite increase of resistance to peritoneal infection and I have reason to believe that it has a real value in human surgery. Recently at The Mayo Clinic intraperitoneal injections of vaccine, with the same object in view, have given encouraging results.

In referring to two stage operations, one must not omit to mention the Mikulicz Paul operation of eventration of the growth in obstructing tumor of the colon. The advantages of this method of dealing with stenosing carcinoma of the pelvic colon in old and feeble subjects are well known. While this practice is tedious, it is eminently safe especially if an interval of some months be allowed to elapse before an attempt is made to close the artificial anus.

The on dwelling clamp operation, a modification of the Mikulicz Paul method, has proved of great value in dealing with large growths in the lower half of the pelvic colon, especially in cases in which multiple resections of intestine were required. In this class of case when, after resection, the lower stump of the pelvic colon reaches just up to the pelvic brim, an end to end anastomosis is difficult of performance and the blood supply of the lower end is precarious. By applying clamps with heavy handles to both ends of the colon, fixing the latter in apposition for 1 inch by interrupted sutures, fixing the clamped ends in the abdominal wound (Fig. 8), removing the upper clamp in 2 days and leaving the lower one to slough off, one has repeatedly been able to deal successfully with tumors which appeared well nigh inoperable. In several cases the lower stump has sloughed for an inch below the clamp but without untoward result. After the application of an enterotome, an interval of 2 months is allowed to elapse. This interval permits retraction of the ends of the colon, a return of the tissues of the abdominal wall to normal suppleness and elasticity and, most important of all, an immense betterment in the general condition of the patient.

#### THE PRINCIPLE OF REPLENISHING PHYSIOLOGICAL LACK.

The cause of death in high intestinal obstruction is a subject which has attracted the intensive interest both of practical surgeons and laboratory workers. Gradually the factors which are operative in producing the condition of collapse so characteristic of this type of obstruction, have been elucidated and, while much remains to be cleared up, we have today in our possession a number of facts which point the way to ultimate solution of this difficult problem. While possibly a chemical substance of albumose type is absorbed from the distended bowel above the obstruction, and while drainage of this obstructed gut will give some relief, we know that death may yet ensue when free drainage is established. The pronounced dehydration which accompanies such obstruction and the call of the tissues for fluid are now recognized to be of

primary importance and replenishment of body fluids the first indication in treatment. The very important fact that a notable and dangerous loss of chlorides occurs in such cases has led to the use of hypertonic saline injections with marked improvement in results. The aspect which I wish to emphasize, however, is that of the deprivation of the bowel below the obstruction of the secretions which should normally descend into it from the upper portion.

We know that in animal experiments high obstruction with immediate drainage of the bowel is not survived for very much longer than an obstruction without drainage. The fluid, which in the bowel above the obstruction may appear to be toxic and threatening the patient's life, may be life saving if it is introduced into the bowel below the obstruction.

This fact was first borne in on me by a case of postoperative obstruction following acute appendicitis which is recorded in the *British Journal of Surgery* (Vol. xi No. 43, 1924), but to which I venture to refer again here. In this case an enterostomy was performed, but the coil opened was evidently below the really active obstruction, for no flow from the tube resulted. Later, on the same day a second enterostomy was performed this time on the highest jejunal coil, and a profuse discharge followed. In spite of copious saline infusion the patient continued to go downhill until the device of joining up the two enterostomy tubes was practiced when the abundant secretions from above the obstruction were conducted through the joined tubes to the intestine below (fig. 9). An immediate and remarkable improvement followed this maneuver, the patient made a satisfactory recovery and he is alive and well today.

This call of deprivation of the empty intestine below in cases of high obstruction constitutes, I believe, an important principle in the treatment of such cases. Brockman has emphasized the benefit of enemata of bile in post-operative ileus, and has shown the important rôle which the absorption of bile from the lower reaches of the bowel has in liver function. There are, I believe, other factors besides bile in the profound physiological upset which results when an obstruction occurs between the active secretory upper part of the small intestine and the absorptive reaches below. The emptying of the upper distended coils, at operation for acute obstruction of the small intestine, say from a band, may, by reducing intra abdominal tension, permit of more vigorous peristalsis thereafter and thus be an advantage. It will not save the patient's life, however, unless subsequent peristalsis results in the propulsion of the content of the higher coils into the empty coils below. The conception of a physiological lack below combined with a pathological retention above is one which deserves our attention and will find a field for application in our practice.

In submitting to your notice these principles of de tension in operating, of intravisceral tension in disease, of complete assessment, of the two stage operation, and of the supply of a physiological lack in obstruction—I feel that I have made a very inadequate contribution to the list of communications delivered in memory of a great man. I am comforted in this, however, that in my endeavor I was guided by the spirit of Murphy in seeking from my own experience to find principles which had a wide application in practice, and in the assurance that in the commonplace we may sometimes find the most valuable guiding lights for our daily work.

HYPERTHYROIDISM ASSOCIATED WITH CARDIAC DISORDERS<sup>1</sup>

FRANK H. LAHEY, M.D., F.A.C.S. BOSTON

A FEW years ago we directed attention to a group of cases of hyperthyroidism with auricular fibrillation and cardiac decompensation and another group with auricular fibrillation alone. The latter group was one of potential heart failure. In the former group, the underlying hyperthyroidism, as being the cause of heart failure, had in a considerable measure been overlooked. The degree to which cardiac capacity could be regained following the removal of the toxic goiter had not been anticipated nor was the relative safety with which these apparently inoperable patients would withstand a general anesthetic and sub-total thyroidectomy realized.

For the purpose of marking them as an entity and thus directing attention to them so that they would be removed from a group of patients considered hopeless and, as proved by our experience with them, converted to a group in which the most amazing results in thyroid surgery (restoration of cardiac capacity after seemingly hopeless decompensation) could be obtained, we designated them under the perhaps inaccurate but descriptive term "thyrocardiacs."

It has been assumed for a long time—and by some it is still considered to be true—that the effect of hyperthyroidism is a destructive one upon the heart. Upon this assumption, it is sometimes presumed that there is a state which may properly be called "a thyroid heart." For several years I have believed and written that this is not so and that hyperthyroidism in itself accomplishes no destructive effect upon the heart which can be distinguished either microscopically or by the interpretation of clinical findings. Furthermore, there is no laboratory evidence to bear out the idea that the effect of hyperthyroidism is to produce permanent myocardial changes. We have with our increasing experience in the pre-operative and postoperative observation of thyroid cases now amounting to well over 7,500, been more and more convinced that hyperthyroidism in itself does not directly pro-

duce degenerative changes in the heart. In association with Dr. B. E. Hamilton, to whom we are indebted for assistance early in our experience with the thyrocardiac, and now with Dr. L. M. Hurxthal, we have seen several young and middle aged people die either without operation in the acute crises of hyperthyroidism or in the acute postoperative or so called thyroid storms. No matter how great the intoxication, regardless of the uncountable rates to which the pulse rose, there was none of the clinical indications of failing compensation. The patients were not orthopneic, they could lie flat without embarrassment, there was no oedema and there was no enlargement of the liver. We have further observed after operation a very large series of patients who, without previous heart damage, have suffered the effects of hyperthyroidism over long periods of time and in whom relief of hyperthyroidism with restoration of the cardiac rate to normal range has resulted in a heart which is as capable as one which has never been subjected to the effects of hyperthyroidism. This does not mean that there are no patients in whom relief is not complete, but that, in those patients without previously existing heart damage where the relief from hyperthyroidism is complete, no permanently damaging effects of the hyperthyroidism are recognized in the heart. In all patients dying of hyperthyroidism, we have also sought by autopsy to demonstrate effects upon the heart which might be considered the results of prolonged hyperthyroidism, but we have not been able to recognize any.

It has always been our belief, and one which is shared by Dr. Hurxthal, who has had the opportunity of observing a large number of thyrocardiacs in the Lahey Clinic from a medical viewpoint, that cardiac decompensation, associated with thyroidism, is due to the effect of thyroidism upon a previously damaged heart rather than the damaging effect of thyroidism upon the heart. The relative infrequency with which cardiac complications occur

<sup>1</sup> Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 24, 1930.



in young people and their frequent appearance in patients in late middle and the later years of life, when sufficient time has elapsed to acquire cardiac damage, lends weight to the probability of this assumption.

This hypothesis also permits a reasonable explanation of the operability, the degree to which the patient may be relieved of his cardiac decompensation, and the remarkable capacity for sustained effort which he or she can regain following the relief from hyperthyroidism. These conditions, under which the factor causing the heart failure to appear and persist can be removed surgically, have no parallel in heart conditions.

There are several factors which are responsible for the ease with which underlying hyperthyroidism as a causative factor in cardiac failure has been so often overlooked. One is that the urgent and most evident portion of the picture of cardiac failure due to hyperthyroidism is the cardiac failure, the distressing orthopnea, the edema, and at times the ascites and general anasarca. Another factor is that the underlying heart disease may be correctly diagnosed by the internist, because of a history of rheumatic infection and the finding of valvular lesions, yet hyperthyroidism as the precipitating cause be overlooked.

These features particularly direct one's attention to this pressing side of the picture, especially when it is realized that the evidences of hyperthyroidism, when associated with heart failure at the age period in which it so frequently occurs, are usually far from typical in comparison to the features of the disease in a young and active person without associated cardiac damage. Furthermore, in the primary or exophthalmic type of hyperthyroidism, the thyroid gland is not only without enlargement but is often not of sufficient size even to be visible and, to add further difficulty to the diagnosis, the hyperthyroidism often associated with cardiac decompensation evidences itself, not by the striking and typical activation of hyperthyroidism as seen in young and active individuals, but rather by a form of hyperthyroidism characterized by apathy in contrast to activation.

In a recent paper on the thyrocardiac, the subject of the apathetic type of hyperthyroid

ism was discussed at some length, but, at the risk of repetition, I would like to stress the necessity of understanding the seriousness of the non activating type of hyperthyroidism which is so commonly found in thyrocardiacs and which we have frequently written about under the term "apathetic hyperthyroidism."

Every one is familiar with and cannot fail to be impressed with the apparent seriousness of the activating type of hyperthyroidism which is observed particularly in young and vigorous individuals. The bounding, rapid pulse, often of startling rates, the pounding heart action, the flushed face, the constant agitation impress upon one, almost beyond possible error, that here is a serious and dangerous situation. On the other hand, however, is the other type of hyperthyroidism, less well known, less typical very much less striking about which little has been written but which possesses the most serious possibilities of fatal outcome. It is characterized by non activation, by only moderate elevations of pulse rate and by pulses of not particularly bounding quality. This is the apathetic type of hyperthyroidism and is often the cause in itself of failure to recognize this type as the underlying cause of heart failure. It is this type of hyperthyroidism, unassociated with cardiac states, which leads one to do unjustifiably, extensive operations upon the thyroid. Many patients with hyperthyroidism of this kind maintain very reasonable pulse rates during operative procedures, which fact associated with lack of activation, leads one to do complete thyroidectomies, only to have the patients die after operation by progressing into the deepening state of apathy, finally to succumb in peaceful unconsciousness as opposed to the wild excitation of a thyroid storm. These are the cases in which it is so difficult to estimate pre-operatively the capacity to withstand operative procedures, and just as apathetic thyroidism must be carefully looked for in cardiac decompensation suspected to be due to a possible underlying thyroidism, so it must be balanced as to the extent of operability in thyroidism of the apathetic type unassociated with cardiac decompensation.

We have repeatedly stated that the operability of patients with cardiac decompensation due to associated hyperthyroidism, as

proved by our own experience, is far greater than used to be thought possible. We have definitely proved that many, if not most, of the thyrocardiacs in severe decompensation who were in the past rejected as inoperable, are today not only operable but operable with only a reasonable mortality. Up to about 2 years ago, we had operated upon 138 thyrocardiacs and have since been able to ascertain, chiefly by examination, the exact status of most of them. The operative mortality in this group of 138 was 3.6 per cent, 5 having died. Of those dying after operation while still in the hospital, 1 death was from postoperative mediastinitis following the removal of a toxic retotracheal adenoma in a patient with severe decompensation, 1 from status lymphaticus (autopsy finding), 1 from pulmonary embolus, and 2 were sudden, from unknown causes (no autopsy). Within the past 2 years the operative mortality has been materially reduced. This group represents one in which there were no rejections on account of decompensation.

We have operated upon all but 4 patients of the thyrocardiacs who have come into our hands. Operation was not done in these cases for the following reasons: 1 died of bronchopneumonia before operation could be done, 1 toxic patient had, in addition, hopeless malignancy, 1 patient died of tracheal obstruction before operation, and 1 patient refused operation.

When one realizes that some of these patients were so breathless that they had not been able to lie flat for weeks, had general anasarca and a few could not be relieved of their decompensation by any measures then available, and yet withstood a general anesthetic (ethylene) and a subtotal thyroidectomy, within a few days regained their compensation, and within a few weeks could walk out of the hospital, one realizes that there are no patients too badly decompensated to be rejected and to be able to regain their compensation to such a degree as to be up and about in a reasonably active capacity.

We do not make this statement, that we have rejected practically no patients because of the degree of their decompensation or that there are no patients with cardiac decompensation due to hyperthyroidism too ill for operation, with any spirit of assertive pride, but

rather with the idea that it will prevent seemingly hopeless patients with this condition from being denied the possibility of relief and thereby, a lengthened and useful life.

An explanation of the ability of some thyrocardiacs to withstand a general anesthetic and subtotal thyroidectomy with a surprisingly low mortality rate is doubtless the fact that any patient with cardiac decompensation and thyroidism who is able to get to the hospital and to stay alive there long enough to have the matter of operation considered, must necessarily possess a considerable degree of cardiac reserve. Often one of the features of the cardiac decompensation associated with hyperthyroidism is that because of the underlying hyperthyroidism, it has been impossible, with rest and appropriate medical measures, to restore compensation. Nevertheless, those patients who reach the hospital usually do not become progressively worse while resting and under observation. Every patient, therefore, with a cardiac decompensation which persists in spite of seemingly adequate therapeutic measures, should be carefully investigated as to the possible presence of a hyperthyroidism as the causative factor in the decompensation, and, furthermore, every case of auricular fibrillation must be thought of in terms of a possible hyperthyroidism, just as hyperthyroidism must be considered as the possible cause of every glycosuria.

So difficult may be the diagnosis of this possible underlying hyperthyroidism that often but doubtful evidence of it is present, such as moderate exophthalmos or stare, pigmentation, a firm, hard, but not enlarged gland, unexplained weight loss, particularly in spite of good food intake. Any person, therefore, with goiter and heart failure or auricular fibrillation should be suspected of hyperthyroidism, because of the hope which surgery may hold out to him in contrast to the patient suffering from decompensation incited by causes other than hyperthyroidism.

Auricular fibrillation is definitely associated with hyperthyroidism in patients past middle age and is also a causative and promoting factor in cardiac decompensation due to hyperthyroidism. While the relief of hyperthyroidism results in restoration of normal rhythm in

many instances, and is particularly successful in the treatment of transient auricular fibrillation, it is not the purpose of this discussion to dwell particularly upon this cardiac complication of hyperthyroidism. This phase of the subject has been reported upon from the Clinic by Dr L. M. Hurxthal. It is now so generally accepted that permanent or transient fibrillation is no contra indication to partial thyroidectomy that the subject does not need to be considered further here. We have learned from our experience with cardiac decompensation due to hyperthyroidism that every measure which will in any way lessen decompensation pre-operatively should be employed in these cases. We have kept them in bed at rest as long as it was apparent that any degree of relief of decompensation was being obtained. Dr Hurxthal has employed digitalis only in two types of cases—those with congestive failure who did not improve with iodine and rest in bed, and those patients with established auricular fibrillation in whom an excessively rapid pulse rate persisted after a reasonable time in the hospital. Although in the congestive failure cases digitalis may slow the pulse, banish dyspnoea and orthopnoea, and at times promote a diuresis, diuretics (theosin and salyrgan) are frequently employed with excellent results. Fluids are restricted until time of operation but can be given freely after operation. In the established fibrillation group, digitalis renders a slower and less alarming pulse rate throughout anesthesia and is a safe brake on the heart for any postoperative complication which might precipitate an added load on the circulatory apparatus.

Quinidine is reserved for auricular fibrillation until after operation because of its apparent greater toxicity in the thyrotoxic patient and because of the liability of the recurrence of auricular fibrillation immediately after or during operation. The percentage of return to normal rhythm following operation has been increased from 52 per cent without quinidine to 76 per cent with quinidine.

In the beginning of our operative experience with patients having cardiac decompensation and thyroidism, we believed that it was necessary to do the partial thyroidectomy with local anesthesia. We have for the last 3 years em-

ployed ethylene in all operations upon thyrocardiacs except those with dangerously elevated blood pressure. Ethylene with its high mixture of oxygen has proved just as safe as and far more comfortable than, a local anesthetic for the patients. Dr Hurxthal, in whose hands rests the management of the heart conditions in these patients, has called our attention to the desirability of anesthetizing and operating upon the more serious cases in the upright position—a very wise suggestion. If it is difficult for decompensated patients to breathe while conscious in the reclining position, it is probably an added cardiac burden for them to be anesthetized and operated upon in that position.

We have found it most desirable to do complete subtotal thyroidectomy on thyrocardiacs with decompensation, since relief from decompensation is most likely to be obtained with the greatest degree of relief from thyroidism. While a complete one stage partial thyroidectomy is to be desired, it cannot always be accomplished with justifiable prospects of toleration by the patient. In such a case we have divided the operation into two stages: a right first stage subtotal hemithyroidectomy and a later left second stage subtotal thyroidectomy. It is extremely important even though the right first stage subtotal thyroidectomy accomplishes relief of decompensation that the patients should be kept in the hospital under supervision and treatment until ready for their second stage procedure. We have found this necessary because of the fact that we have permitted patients to return home between stages when relieved of decompensation by the first stage procedure only to have them return to us again in decompensation because of undue exertion, intercurrent infection, and, in one case, an alcoholic excess. Because of these experiences, we urge that patients be kept under observation until relieved to the greatest possible degree of their thyroidism.

A study of the end results, as reported in a recent communication on this subject involved the investigation of 147 patients who might be classified as thyrocardiacs. Of this number 18 are untraced and the outcome in only 124 is known. Five died operative

deaths while still in the hospital, an operative mortality of 3.6 per cent. The types of death were given earlier in this paper. Fourteen have died since operation. Of this number 4 died with congestive heart failure, 3 died sudden deaths, 1 died of pneumonia, and 4 died of undetermined causes. Two other cases died of causes other than heart failure after leaving the hospital. Four were not operated upon, for reasons enumerated in the earlier part of my remarks. One hundred and one cases are alive and their condition known.

Of the 101 thyrocardiacs operated upon and now alive, 76 have full return of the function enjoyed before the onset of hyperthyroidism, 19 have persistent auricular fibrillation, 4 are partially disabled, and 9 are completely disabled.

The average duration of cardiac symptoms before operation as given by the histories in these studies when obtained was  $2\frac{1}{2}$  years. The average number of years during which the 101 patients who are alive after operation have now been well and active in the degrees above stated is  $3\frac{1}{2}$  years.

The age incidence is grouped below.

Age	No. of cases
20 to 29	1
30 to 39	17
40 to 49	37
50 to 59	56
60 to 69	27
70 to 75	4
Total	142

The incidence of established auricular fibrillation in the 142 cases before operation was as follows:

Established auricular fibrillation (8, 4%)	122
Paroxysmal tachycardia (1.4%)	2
Normal rhythm (12.6%)	18
Auricular fibrillation with clear cut congestive failure	92
Normal rhythm with congestive failure	18
Auricular fibrillation without clear cut congestive failure	30
Paroxysmal tachycardia with congestive failure	1
Paroxysmal tachycardia without congestive failure	1

If we throw out all except the clear cut failures, 30 cases we may group under mild failure 55 cases, those patients having oedema and marked dyspnoea on attempted activity,

under moderate failure, 14 cases, those having oedema, enlarged liver, and orthopnoea and requiring rest in bed and active treatment, and under severe failure, 42 cases, those with anasarca, hydrothorax, large liver, orthopnoea, and dyspnoea at rest and requiring intensive medical treatment.

Of this entire group of cases operated upon, 49 were adenomatous goiter with secondary hyperthyroidism and 93 were exophthalmic goiter or primary hyperthyroidism, indicating that toxic adenomata are no more apt to produce cardiac complications than is primary hyperthyroidism or exophthalmic goiter. The incidence of type of thyroidism corresponds in these figures to the incidence of type of the disease as it occurs in our community.

### CONCLUSIONS

It is therefore concluded that

1. Thyroidism in itself does not by its direct action upon the heart produce destructive changes in the heart.
  2. The thyroidism frequently associated with cardiac decompensation is atypical and of the apathetic type.
  3. Thyroidism of the apathetic type is less striking and much more dangerous than thyroidism of the activating type.
  4. There are practically no cases of cardiac decompensation due to associated thyroidism which cannot be submitted to surgery with only a reasonable risk.
  5. The possibility of restoration of cardiac capacity after removal of the associated thyroidism in thyrocardiacs is extraordinary.
  6. Toxic adenomata are no more apt to cause cardiac failure than is primary hyperthyroidism or exophthalmic goiter.
- Suggestions as to the handling of these cases are made upon the basis of our experience with them. To substantiate the above conclusions an end result report on 142 thyrocardiacs is submitted.

### DISCUSSION

DR H. M. RICHTER, Chicago. Dr Lahey and his associates have done much to focus attention on the frequent etiological relationship of thyrotoxicosis to heart disease. Five years ago Hamilton presented a splendid piece of work on this subject from the Lahey Clinic before the American Medical

Association in which he called attention to the frequency with which this thyroid background is overlooked. The clinical effect of hyperthyroidism on the heart is common knowledge. "Hyperthyroidism masked as heart disease" to quote a phrase coined by S. A. Levine of Peter Bent Brigham Hospital is still unsuspected by too many internists of the first rank and is almost entirely unknown to the general practitioner.

My experience with the association of thyrotoxicosis and heart disease has been along parallel lines to that of Dr. Lahey though on a much smaller scale. My observations of the more detailed cardiac damage have been less complete. The internists associated with me have repeatedly seen the manifest effect of detoxication by thyroidectomy on the damaged heart but they rather than I have interpreted in more exact terms the significance of the pre-operative cardiac manifestations and the change wrought by operation.

Serious cardiac damage has presented itself in my material mainly in older patients. In a group of 55 advanced cardiac cases picked from a consecutive series of 1,000 patients subjected to thyroidectomy 37 or 68 per cent were over 50 years of age whereas of the entire 1,000 only 6 per cent were over 50 years of age. One must differentiate between patients who exhibit unrelated cardiac changes upon which thyrotoxicosis has been superimposed and the true thyrocardiacs. We cannot expect to relieve the former group of their organic damage. It has been my impression that thyrotoxicosis in the aged tends particularly to damage a heart handicapped by earlier organic changes. Autopsy findings have commonly failed to show extensive gross changes or specific changes. That thyrotoxicosis has a selective action on a previously damaged heart and leaves the normal heart of the younger patient relatively unharmed would be difficult to prove. More exact histological methods show enough cardiac damage to suggest that long continued thyrotoxicosis may leave serious permanent injury. The group here considered was composed of constant or intermittent fibrillators at the time of operation. Forty three ceased fibrillation before their discharge from the hospital.

Cardiac decompensation like fibrillation yielded in great measure to adequate iodine therapy and thyroidectomy. Some of these patients with an unrecognized thyroid basis had been resistant to persistent treatment along recognized lines for cardiac disease only to respond promptly to thyroidectomy. It is significant that the more serious cardiac damage was usually associated with unrecognized thyrotoxicosis of long standing. The ultimate results as contrasted with the immediate improvement have been less satisfactory. Restoration of compensation has not always been permanent. In cases of organic heart disease high blood pressure and fibrillation the usual sequelae must be anticipated in spite of complete relief of the thyrotoxicosis high blood pressure in particu-

lar causing disappointment in its failure to yield to thyroidectomy.

This group as a whole presented much less obvious increased excitability, though it included a few patients showing high grade mental disturbances. Five changes were relatively infrequent. Tachycardia was far less constant than in the younger patients with acute hyperthyroidism.

Weight loss and elevation of metabolism were almost universal. The average pre-operative metabolism of these 55 patients was plus 57, 33 or 60 per cent averaged plus 72, 13 or 24 per cent averaged more than plus 80. Yet one had a consistently low metabolism repeatedly falling to within normal.

In the absence of a rounded out thyroid picture the most important diagnostic criteria have been in the order of their importance: a raised basal metabolic rate which alone in the absence of obvious reasons for its existence justifies the diagnosis; the response of the patient to full therapeutic doses of iodine; weight loss, physical weakness and tremor. I have seen no case in which either cardiac disease or high blood pressure not associated with hyperthyroidism has been associated with a subnormal raised metabolism.

The use of full doses of iodine as a therapeutic test of thyrotoxicosis ranks in value with the therapeutic test for syphilis in pre-War eras. The clinical effect rather than the effect on metabolism alone determines the diagnosis. Cardiac irregularity in questionable cases is always strongly presumptive of thyrotoxicosis.

Finally I subscribe wholeheartedly to Dr. Lahey's attitude toward the surgical treatment of the thyrocardiac. These patients respond to properly directed preparatory treatment. The mortality in these cardiac cases has been reduced to the level of that of general abdominal surgery.

In my own work iodine has been the mainstay in preparatory treatment. Radiotherapy is not used. Prolonged bed rest, or other form of delay is objectionable. The duration of the iodine preparation in the cardiac group has ranged around 4 weeks.

Thyroidectomy detoxicates the patient. It meets the requirement of James Mackenzie who in speaking of the poisoned heart of any variety said:

The appropriate treatment is to get rid of the poison. Simple as this proposition seems yet it is wonderful to find how often it is neglected or if not neglected how attempts are made to cure the heart condition as if it were something apart from the intoxication. This criticism of Mackenzie's clearly applies to the treatment of the thyrocardiac patient by any method short of adequate thyroidectomy.

DR. O. E. MAREAU, Chicago. Anyone with the clinical experience the judgment and the ability to analyze his work no matter in what phase of medicine possessed by Dr. Frank Lahey must be judged an authority and so it is with Dr. Lahey on the subject of goiter in its various manifestations.

While it may be true that the cardiac conditions seen in goiter are not proved to be those of definite

degeneration or inflammation of heart muscle, still the interrelation between the two is so definite and so relatively constant that we must consider thyrocardiac disease a definite entity. Therefore, even despite Dr Lahey's arguments we may say for purposes of this discussion, that goiter does produce cardiac and circulatory pathology and must take a more important place in the cause of heart disease than it has been considered to do in the past.

To illustrate why we believe goiter not to be sufficiently stressed in the consideration of the causes of heart disease, I shall cite a few references from the literature. (1) Sir James Mackenzie in the *Oxford System of Medicine* makes no mention of goiter as a factor in heart disease. (2) Alexander Lambert, in Tice's *System of Medicine* states that the nervous excitability and hypertension accompanying goiter may have an influence in producing cardiac disease. (3) Paul White of Boston, in Nelson's *Loose Leaf Medicine* published in May of 1920 states that 2.9 per cent of 2,421 cases of organic heart disease were associated with but not necessarily caused by, hyperthyroidism. (4) Myers and Ick, in Iowa found 1.5 per cent of 263 organic heart cases probably due to goiter. (5) Vasquez Laidlow mentions Graves' disease only in the etiology of tachycardia.

It is, of course evident that the importance of goiter as a cause of heart disease must vary with the geographical location of the cases studied. Therefore statistics from the southern states for instance would show very few cases of heart disease due to goiter because there are so few goiters. However, in a locality such as the Great Lakes drainage district the incidence of heart cases aggravated by goiter must be much higher.

Another factor is that of the insufficient recognition by the profession in general of the correlation between the heart and the goiter. It is undoubtedly true that many cases of heart disease are seen in which thyroid disease is also present in the same patient but in which the interrelation of the two is not recognized until late in the course when a history of thyrotoxic crisis is obtained.

Is there any difference between exophthalmic goiter and toxic adenoma? We believe that they are the same disease and that the only difference is the chronicity or stage. In other words exophthalmic goiter is an acute hyperthyroidism, toxic adenoma being a chronic form of the same disease. A study of many specimens gross and microscopic of removed thyroid glands will convince one that the pathological anatomy of toxic adenoma is practically identical with that of exophthalmic goiter. What does this mean? To my mind it can be an-

swered only by a thought that with each light attack of exophthalmic goiter in the chronic cases there is left a small island of hyperplasia which eventually continues to grow, thus forming an adenoma. These adenomata then degenerate into the various forms seen in cases of toxic adenoma, such as cysts and calcareous masses.

Although the cause or causes of goiter are not known at the present time it would seem that the factors producing the clinical entities of acute hyperthyroidism and chronic hyperthyroidism are the same that cause cardiac decompensation both in cases of exophthalmic goiter and so called toxic adenoma of the thyroid gland.

In order to obtain information in the Percy Clinic at the Augustana Hospital about the incidence of heart disease in goiter we reviewed 1,509 cases of goiter operated upon between September 1, 1927, and September 1, 1929. Of these cases we considered 28.3 per cent to be 'thyrocardiacs'. They do not include cases of simple tachycardia or other mild symptoms of hyperthyroidism but only those cases in which it seemed evident that there was some form of actual cardiac disease. Of the total number of cases 8.4 per cent had auriculo fibrillation. The postoperative mortality rate was 1.8 per cent, two thirds of which was due to heart failure. A systolic blood pressure of 160 mm. or over was present in 18.2 per cent of the cases, which figure is to be compared with other statistics in the frequency of hypertension in thyroid disease.

Heart disease of this type as Dr Lahey has told us is therefore preventable and there is nothing so striking in the treatment of any disease as the relief of symptoms in a case of cardiac manifestations due to goiter. A thyroidectomy produces such rapid and often permanently beneficial results that no case of goiter with even the earliest of cardiac signs should go without treatment. It is, of course, essential that such patients should be treated very early in their course to prevent any permanent damage to the heart muscle which might preclude the perfect recovery expected in an early case well treated.

In conclusion we may state:

1. Cardiac disease due to goiter is largely preventable and much can be done to educate the public in the benefit of early treatment.

2. Goiter as a cause of heart disease has not received sufficient attention in those geographical areas where the incidence of goiter is high.

3. Although the causes of goiter are not known it would seem that exophthalmic goiter is an acute phase, and toxic adenoma a chronic phase of the same disease.

# THE DANGERS INVOLVED IN THE OPERATION OF THORACOPLASTY FOR PULMONARY TUBERCULOSIS<sup>1</sup>

EDWARD W. ARCHIBOLD M.D. F.A.C.S. MONTREAL, QUEBEC

THE operation of extrapleural thoracoplasty for certain forms of pulmonary tuberculosis, born in 1908, has in this year reached its majority, and one may say unhesitatingly that it has deservedly acquired full rights of citizenship. It found first a wide acceptance in Germany, Switzerland, and Scandinavia, in which countries the number of operations performed must now amount to several thousand. In England and France, where medical opinion is apt to be more conservative, the operation was taken up rather later, and the same is true of this continent. However, although we on this side of the water, with two or three exceptions, allowed some 10 or 15 years to elapse before we realized the very great value of the procedure, our usual enthusiasm for the new thing, stimulated as it soon was by early successes, has rapidly grown. At present throughout the country the operation is being done and done sometimes by men who are insufficiently educated in the fundamentals of tuberculosis, and who are apt to regard the operation only from the standpoint of surgical technique.

Up to 1914 only 3 thoracoplasties had been performed on this continent. In 1910 the writer reported a series of 12. Over 3 years ago a questionnaire sent out to all those who were engaged in this work showed that at that time between 300 and 400 thoracoplasties had been done. At the present moment, though I have not accurate figures at my disposal, I feel sure that well over a thousand must have been carried out in this country. Now, from published reports and from numerous conversations, I have reason to believe that this enthusiasm threatens to go beyond proper bounds. Enthusiasm without adequate knowledge becomes a dangerous thing. Nor can knowledge itself escape the same reproach if it be not corrected by that wisdom which comes only from study and reflection. I have the best reason to think, judging from my own experience, that a good

many patients have been operated on who should not have been operated on, and that a good many deaths have occurred as the result of rash enthusiasm unsupported by sufficient study, the blame for which lies at the door of the surgeon as well as of the physician.

Consequently I have thought that it might serve a useful purpose to review before you the causes of death as discovered in the study of my own series of cases.

The remarks which follow are addressed not only to the surgeon, but also to the physician and in particular to those physicians who devote themselves chiefly to the treatment of tuberculosis of the lungs. To the former I must say something about the technique of the operation, and to both something about the proper selection of cases. And to begin with, it is necessary to lay down certain principles which apply to the treatment of all forms of tuberculosis.

The first is that while nearly everybody sooner or later is attacked by the tubercle bacillus only those who possess resistance by inheritance or their natural constitution or who have acquired it through environment or treatment are able to overcome this attack. Disregarding the very large number of those who do overcome it without ever knowing they have been attacked we may consider only the question of declared or clinical tuberculosis. In the patients suffering from clinical tuberculosis resistance is made evident by certain well known pathological processes familiar to everybody, chief of which is the replacement of the tubercle by fibrous tissue, representing nature's attempt at healing. Fibrous tissue turns into scar, and the chief property of scar tissue is to contract. Consequently, this first principle amounts to this: that in considering the question of operation we should look for the evidence of scar contraction in diseased lungs because we must absolutely depend upon the help of nature, that is, of the patient's resistance, to aid

<sup>1</sup> Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 14-15, 1920.

effectively the surgeon's work. We see this evidence of scar contraction both in the ordinary physical examination and particularly in the X-ray picture. Inasmuch as the ribs form a fixed point while the thoracic organs are mobile, scar contraction will pull the trachea, heart, mediastinum, and diaphragm toward the fibrotic lung tissue and toward the ribs of the affected side.

The second principle is that the fundamental factor in the cure of tuberculosis is rest of the diseased tissue. Thus, for instance, we immobilize joints, and we try to immobilize the lung by putting the patient at rest and reducing the work of respiration. This is exemplified in the ordinary hygienic treatment of pulmonary tuberculosis. In certain cases more complete rest of the affected lung can be brought about by artificial pneumothorax. And finally when this last is impossible on account of pleural adhesions, the principle is still further exemplified by the operation of extrapleural thoracoplasty, which, by removing portions of eleven ribs, prevents respiration on that side, puts the lung at rest, and also compresses the lung. This is the *rationale* of the operation.

To put it briefly, then, the chief danger arising out of the first principle lies in choosing for the operation patients who do not show natural or acquired resistance, and the chief danger arising out of the second principle lies in putting out of function suddenly too large an area of the diseased lung.

Let us take these up in their order—first the danger of operating upon patients whose resistance is insufficient to stand the strain of a thoracoplasty. The course of tuberculosis clinically may run along two main lines, the one showing a tendency to chronicity with the gradual laying down of repair tissue in the form of fibrosis and ultimate scar, that is a tendency toward healing, even if combined usually with some degree of local destruction in the shape of cavities. This is the productive form. The other tends toward activity and is characterized by quietly or rapidly progressive infiltration of a bronchopneumonic type with or without cavitation and liquefaction, but usually with fever, rise of pulse, and loss of weight and strength. This

is the so called exudative form. Here there is very little evidence, if any, of nature's attempt at repair in the way of fibrosis, and consequently one misses the evidence of scar contraction. Between these two general types comes a large number of cases in which there can be found, as one reviews the histories, a sort of up and down course, with attempts at fibrosis marred by successive shoves of fresh tuberculous infection invading new ground. The number of variations or combinations of these two types is a large one, and each case must be studied on its merits with this fundamental principle constantly in mind. Now it may be laid down as a safe proposition that the patient who shows no evidence of fibrosis, whose history demonstrates a tendency to activity, and whose lesions are at the moment active, even though the disease be strictly unilateral should not as a rule be operated upon because the undoubted strain of operation is very likely to aggravate the disease, since nature contributes nothing in the way of help. How much more is this true when, as is often the case, there are present the evidences of similar, even though slight, disease of an active nature in the opposite supposedly good lung. I find, indeed, that a common error is to operate on such patients because of the fact that the disease is chiefly unilateral, in order, as has been said, to give the patient his chance. This is to disregard entirely the fundamental requisite of resistance, without which any strain added to the load which the patient is carrying merely makes that load heavier. The results are apt to be disastrous. The slightly active disease on the good side may easily go on into heightened activity, invade fresh areas of the lung and become so extensive as to amount to a pneumonia, thus forcing the patient into a negative phase which ends in death within a few days or a few months. Let me emphasize, then, that it is usually impossible to bring help to a patient whose whole history shows that he cannot help himself. On the contrary, only harm is done.

The right selection of cases, therefore, is of paramount importance, and the greatest danger of operation lies much more in lack of judgment in that selection than in eventual



# THE DANGERS INVOLVED IN THE OPERATION OF THORACOPLASTY FOR PULMONARY TUBERCULOSIS<sup>1</sup>

EDWARD W. ARCHIBALD M.D. F.A.C.S. MONTREAL, QUEBEC

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progression of the disease through previously healthy, or almost healthy, portions of the lung, in particular of the opposite lung. Death, if it occurs, comes usually only after weeks or months, although in one of my patients it ensued on the eighth day after operation. But there is a second, more immediate, danger to life, which arises from a disturbance of the physiological equilibrium, both of respiration and of heart action. When one removes a sufficient number of ribs and a sufficient length of those ribs, one brings about a reversal of the normal physiological movements of the underlying lung, in the sense that during inspiration this portion of the lung, having no expanding ribs over it to bring it out, follows the expansion of the opposite lung and is therefore pulled in toward the opposite side, while in expiration it takes the opposite movement, being shoved out by the contraction of the opposite lung. This is called paradoxical respiration. The practical result is that this portion of the lung becomes inert and is of very little use, if any, for purposes of aeration. Even the removal of two or three ribs over a length of from 4 to 5 inches will allow this phenomenon to appear. It follows that the more ribs one removes and the greater the extent of the ribs removed the more lung will be put out of action and the greater will be the loss of oxygenation and reduction of vital capacity. Not only has this a serious effect upon the patient's ability to breathe properly, but the action of the heart also is interfered with, because there ensues a sort of swinging or flapping movement of the mediastinum and of the heart, corresponding to the phases of respiration. The heart loses its normal support and its work is disturbed. It is the rule that the removal of from 4 to 6 inches of the lower five or six ribs increases the heart's rate by 20 or 30 beats for a period of a week or more. The extra labor is obviously considerable. If all the ribs are taken off at one sitting, as used to be advised by continental surgeons, even a healthy heart is frequently unable to stand the strain. A failing heart then brings on pulmonary edema and many a patient in the earlier periods of this operation died in this way in the course of the first few days

after operation. On the other hand, it is well known that if the mediastinum has been stiffened by long standing fibrosis or by a pre-existing pneumothorax or by chronic empyema, the extensive removal of ribs is much better borne by the heart, and the pulse rate after operation may rise but very little. These physiological conditions have often been too little regarded by those whose natural mind and whose training have made them confuse fine surgery with fine technique. So that the second warning is not to take off too many ribs, nor too long a piece of each rib, at one time.

We owe to Dr. Hedblom chiefly, in this country, and also to Colonel Keller the principle of the graded thoracoplasty, which means multiple operations and but little at a time. There is no more certain way of playing safe. At a time when the continental practice was all in favor of removing ten or eleven ribs in one stage, the wiser surgeons were advising two stages, and at the present moment there is a distinct tendency, to which I heartily subscribe, towards a three stage operation. My own opinion is that whenever there is a suspicion of recent activity in the good lung (if this were a certainty one would not operate at all), it is well to remove no more than three or four ribs at a time, but in the majority of cases, properly selected, it is safe to remove from the sixth to the eleventh inclusive at a first stage and the upper five about 2 weeks later. As a matter of fact, as one sees from photographs taken between the two stages, the removal of the lower six ribs does not put a very large area of lung out of commission. The collapse of the chest wall is kept within reasonable bounds by the buttress of the upper five ribs. On the other hand if one begins at the top and removes the upper six or seven ribs first, as has been advised particularly by Alexander and by Lihenthal, the degree of lung collapse is very much greater, and the sudden interference with aeration, the sudden large loss of vital capacity, constitutes a distinct element of danger. If in addition, the myocardium is not normally sound, the danger becomes most threatening, and in the few cases in which I have tried this method, the mortality has

errors of operative technique I shall perhaps do well at this point to illustrate this statement by a brief reference to the results obtained in my own series of cases. I have divided my patients into 3 main classes: the first includes those of ordinary fibrocascous disease, of chronic type, in which the lung fills its side of the thorax, the second includes the cases of pneumothorax in which it is proposed to give up the pneumothorax and substitute a thoracoplasty, and the third takes up all the cases of empyema, whether purely tuberculous or grave mixed infections.

Now all of them may be divided again into 3 groups, as regards operative risk: the favorable cases or the so called good chronics, the doubtful or conditionally favorable cases, and finally the definitely unfavorable risks. Of the good chronics I can report on 47 cases, with 2 deaths from the operation, that is, 4.3 per cent. In one of these, a one stage operation, the patient died on the eighth day from an acute tuberculous pneumonia of the opposite lung. In this case and one other I broke my rule of never operating in one stage, and I think it probable that if I had taken two stages for the operation the patient would have been alive today. In the second group, that of doubtful cases, there is a series of 71, with 3 operative deaths, a mortality of 4.2 per cent. And in the third group of definitely unfavorable cases, 54 in number, 14 died from the operation, which is a mortality of approximately 26 per cent. If figures can drive home the realization of the necessity of care in the selection of cases, surely these statistics should constitute a sufficient warning in that respect. Our greatest problem, involving our greatest danger, lies here.

It is not my purpose at this time to speak of the favorable results following upon this operation, but I may allow myself a moment to put before you the reverse of the medal. In the class of good chronics, as calculated a year ago, I count 66 per cent of practical cures, that is, of patients restored to community life and able to work, with a further 13 per cent of great improvements. In the cases of the second group, or of doubtful risks, there were 38 per cent of practical cures and 24 per cent of great improvements, while in

the last group, carrying a bad prognosis, the cures were no practical cures and only about 20 per cent of marked improvements.

Now you can see from these figures that although I have tried to be careful in the selection of cases I have frequently failed. In the fifty odd patients of the third, or unfavorable, class I was guilty of many errors of judgment. The reason is clear, and I think I can condense it into a few words which are that, in spite of sticking to the principle of demanding the evidence of scar contraction, I gave insufficient weight to the finding of potentially active lesions on the good side and to the evidence of a general late loss of resistance, coming on after an early period of resistance. Most of these unfavorable cases were on the border line between operability and non-operability, and such are always being sent in ever increasing numbers, to the surgeon who has acquired a certain reputation in this line. And they are sent sometimes by internists and even by professed specialists, at much too late a period, when they are going downhill, often years after an early stage characterized by resistance and fibrosis, at which time they might have been operated upon safely. Let me say that, when a patient who has been under medical treatment for a period of 1 or 2 years has made clear his resistance by fibrosis but has obviously reached a stage at which sanatorium treatment can accomplish nothing further, he should then while he is in good condition, be considered as a candidate for thoracoplasty. He is then still a good chronic and the operation yields very satisfactory results. This remark is addressed chiefly to the medical man, and I would remind him that upon his shoulders lies the primary responsibility in the selection of cases for the operation. The surgeon on his side must always realize that he cannot in his conduct of the case do without the constant co-operation of the internist. It is the internist who from his long observation of any given patient, is best able to estimate that patient's resistance, to determine the pulmonary condition between stages, and to evaluate the final results.

In these remarks I have discussed the danger which lies in an acute postoperative

lung filled its side of the thorax, 12 in which a pneumothorax partial or complete, was replaced by a thoracoplasty, and 25 in which an empyema cavity, with or without a partial pneumothorax, was obliterated or reduced in size by a thoracoplasty. Now it is an interesting thing that 16 deaths, a great majority of all those ascribable to operation, occurred in the first series of 117, while in the 55 cases of the second class there were only 2 deaths. The reason is clear. When the mediastinum has been stiffened by a long continued pneumothorax or an empyema, one escapes the danger of disturbance of the respiratory and cardiac function.

#### CONCLUSIONS

In conclusion, may I set down a brief analysis of the causes of death in the 19 patients who succumbed? Of these deaths, 7 resulted from an acute spread of tuberculosis in the opposite or good lung within a period which varied from 5 days to 4 months. In some of these, undoubtedly, secondary heart failure and pulmonary oedema, coming on within the first week, played a secondary rôle but decided the issue. Three of these 7 showed before operation a definite though slight activity of the disease on the good side and should not have been operated on at all. One was a one stage operation, which in my opinion is to be condemned. In the other 3 cases rapid extension of disease must be accepted as one of the accidents belonging inevitably to any large series of cases. I do not know how certainly to forestall such disasters.

Of the same nature is 1 death that occurred from typhoid contracted in the hospital in the course of a most promising convalescence. Acute myocardial failure caused death in 2 cases on the second day after operation both after the first stage in which the lower five and six ribs had been removed. One of these had shown some myocardial disease in the electrocardiogram taken before operation. Both were adjudged bad risks before operation. It is most important to estimate the strength of the myocardium before doing a thoracoplasty, and, when there is any doubt of the ability of the heart to stand the strain the operation should be done in not less than three stages.

One patient died of miliary tuberculosis, which may or may not have been precipitated by the operation. One died of cardiac failure on the twelfth day after the operation, a first stage in which the fourth to the tenth ribs inclusive were removed. This patient was likewise a bad risk. The warning is again not to take off so many ribs at one stage. Another patient died of a secondary hæmorrhage occurring in the gravely infected wound on the seventh day after the second stage. This patient and 1 other, who died of a streptococcus septicæmia 21 days after a first stage, represent the only deaths from wound sepsis in the whole series of over 200 cases, and it should be remembered that this represents also about 400 separate operations. Infection of the wound has been remarkable by its absence. One patient died of a most curious accident, a spontaneous pneumothorax in the thorax of the opposite side, the cause of which I cannot explain. Three patients who had survived quite well a total posterior thoracoplasty, but in whom persistent cavities at the apex suggested a further attempt at compression, succumbed to an extensive apicolysis (carried out in front) in from 5 to 14 days. These were among my early cases, they were all in desperate condition, and with my present experience I should not think of undertaking such an operation. They died from pulmonary oedema consequent upon gradual heart failure combined with spreading bronchial infection. Two others died from the same cause after the usual posterior operation.

As you see, gentlemen, I have made not a few mistakes. The majority of them were due either to insufficient experience, or, with increasing experience, to insufficient caution. Others can be ascribed to the uncertainties of a refined pathological diagnosis, or, finally, to the mistake of yielding to the pleading of patients. This last mistake can best be avoided and the patient still satisfied, if one explains that the patient's best chance lies in further delay (as, indeed, is perfectly true in some instances), that there is need for further building up, and that the operation may only be postponed. But in the last analysis the most frequent mistake lies in operating upon

been excessive. This warning, therefore, is addressed particularly to the surgeon. Let him not be misled by the facility of rib removal, or by the consciousness of doing a technically pretty operation, into removing more than six of the lower ribs at one time.

A corollary to this proposition concerns the length of rib that should be removed. Sauerbruch advised taking out not more than from 4 to 8 centimeters of any one rib. His operation, in that sense, is called the paravertebral operation. Brauer, on the other hand, contended that, in order to secure sufficient collapse of the lung, one should take away practically double the length mentioned by Sauerbruch, so that in his operation the thorax underlying the scapula also disappeared and his procedure was called the paravertebral scapular operation. The published results make clear a distinct difference in the mortality rate. Brauer's larger resections involved a higher mortality rate, although his contention is that they result in a higher proportion of practical cures.

The surgeon who is new to this work will do well to follow Sauerbruch and always remove less rather than more. For my own part I think that one should judge the amount of rib to be removed by the behavior of the lung as observed during the operation. If, after removing the tenth, ninth, and eighth ribs, in a length of 5 to 6 inches, one notes paradoxical respiration, one must conclude that the loss of vital capacity is going to be a considerable one. Then a shorter length is taken of the seventh and sixth, and the removal of the eleventh, always done last because it forms the last support of the diaphragm, may even be postponed to the second stage. During the 2 weeks following, the patient's respiratory balance becomes fairly well re-established, and one may then safely take out the upper five ribs in lengths of 4 to 5 inches, tapering off at the top to a length of 3 inches of the second, and 1 inch of the first, rib.

As experience in this branch of surgery is still not common property, I think it very important that these dangers of which I have spoken should be fully realized. Otherwise, because of the relative facility with which the

operation can be done, the tendency will be to do it in unsuitable cases, if only from mistaken humanitarian reasons. The inevitable result will be an unduly high mortality, and consequently the operation will suffer a discredit which it does not deserve, and proper candidates for the operation will be frightened into a refusal.

A paragraph or two may be given to technical details. I have almost invariably used general nitrous oxide gas-oxygen anesthesia combined with a small amount of novocain for the skin and the intercostal nerves. I fear local anesthesia alone, believing that it carries with it two dangers: that of novocain poisoning (from which I find recorded in the literature 7 deaths), and that of wound infection. Novocain renders the tissues less resistant to infection and the anaesthetization of the intercostal nerves through the intact skin is open to the objection that the needle in unskilled hands, may be driven into the lung and carry infection back into the soft tissues of the thorax.

I have not found any greater danger of extension of the disease to healthy lung on account of interference with cough from the general anesthetic, than is reported by those who insist upon this danger and will use nothing but local anesthesia. I think, too, there is some slight danger in cough as a factor in splashing fluid tuberculous pus into other lobes. Consequently I give two hypodermics of morphia during the hour before operation and I give a general anesthetic, the whole being sufficient to abolish cough, as well as pain and mental distress. The result is a quiet patient and a quiet, orderly operation. The requirements of the patient's safety as well as his comfort are fully met while the surgeon's comfort, a not unimportant factor, is greatly increased.

I have had under my care 212 cases of pulmonary tuberculosis for which some form of surgical treatment has been undertaken. Of these, however, only 172 have been subjected to a thoracoplasty. In the remainder such minor procedures as phrenicotomy, apicolysis, cutting of pleural bands, and costectomy, for drainage only, have been done. Of the 172 thoracoplasties there were 135 in which the

express my conviction that the mortality will thereby be reduced and the indication for the operation extended. Thoracoplasty is identical in principle with artificial pneumothorax in that it produces rest and compression of the lung. The more the thoracoplasty operation can be made to approximate an artificial pneumothorax refill with respect to its effect on the general condition of the patient the safer it will be. Longer segments of ribs may be excised without mediastinal flutter, securing thereby a more adequate collapse.

Allowing a longer interval between stages allows the patient to recuperate and lessens the gravity of a wound infection should it occur. If rib regeneration interferes with the ultimate degree of collapse a later anterolateral costectomy will effect a maximum degree of collapse. The all important consideration is an ultimate adequate collapse effected by as many stages as the patient's condition seems to necessitate.

To summarize conservatism in the selection of patients pre operative management adaptations of the operative procedure to the individual patient and following through to an adequate degree of lung collapse will extend indications and improve results.

DR RALPH B. BETTMAN, Chicago. Collapse and immobilization therapy in tuberculosis has progressed from the early crude attempts with posture application of weights to the affected side or strapping the chest wall with adhesive to the present stage of artificial pneumothorax and extrapleural thoracoplasty.

The operation of extrapleural thoracoplasty brings about a permanent collapse and compression that is excellent. A large share of the credit of popularizing in this country this operation first conceived in Germany belongs to Dr Archibald. The greatest factor of safety which has been evolved in connection with the operation *per se* has been the division of the procedure into two or more stages. Here again Dr Archibald has been a leader.

Although in general the operation now most commonly used has been but little changed from its first form, our knowledge concerning it has been greatly enhanced.

The multiple stage operation has practically supplanted the single stage operation. The importance of including the first two ribs in the resection has been so clearly shown that in spite of imaginary

difficulties in technique no one today would omit this step. The use of ethylene ether alone or in conjunction with local anesthesia has simplified the operation for the surgeon and done away with much of the mental shock for the patient, because no matter how complete the local anesthesia the vibration and sound of the actual cutting of the ribs was a horrifying sensation.

One of the dangers subsequent to extrapleural thoracoplasty has been cardiac embarrassment. For the last 2 years Dr W. S. Priest and I have been studying the reaction of the heart to the changes in position and intrathoracic pressure subsequent to thoracoplasty. This work has been done in our "heart station" at Michael Reese Hospital, where we have taken electrocardiac tracings on all cases before and after operation. We have found that the patients in whom the respiratory mobility of the heart before operation was great were most apt to suffer from postoperative cardiac embarrassment. Patients in whom change in position of the heart was that of a shift rather than a rotation seemed to suffer least. The operation of thoracoplasty seems to throw more of a burden on the heart than does a laparotomy and a heart with myocardial damage which might withstand the strain of a cholecystectomy or stomach resection, may not withstand even a multiple stage thoracoplasty. On the other hand a healthy heart can tolerate surprisingly large shifts to one side or the other as long as little or no rotation occurs. Just how far we will be able to apply our results to practical advantage is difficult to say.

In evaluating the operation of thoracoplasty it must be remembered that in practically every case other remedies have proved ineffective, and that to a large group of individuals thoracoplasty is the only bridge spanning the gap from the sanatorium to active outside life. In my own series of thoracoplasty 40 percent are back in industry. The interesting point about this fact is that every one of these cases except for thoracoplasty would now either be dead or languishing in a sanatorium.

To my mind there is no question that at present the greatest danger of unnecessary loss of health and life associated with the operation of extrapleural thoracoplasty results from withholding the operation in suitable cases because of ignorance of the operation or failure to comprehend the possible good it may offer rather than from any or all operative catastrophes.

patients who simply are too sick to bear it. After all, we, the declared adversaries of the Old Man with the Scythe, with whom there can never be truce, must still realize that Dame Nature has accorded him certain confines within which his power prevails against us and must ever prevail. And his *habeas corpus*, served and carried out, may be a more merciful act than our own *writ* if it takes the form of a grave and painful operation. Pallida Mors (forgive the change of gender) may lay upon the poor victim of an inescapable summons a gentler hand than that of the surgeon whose outlook upon his own science is of the mechanical kind. *Ad nocere!*

The moral I draw is that for the sake of the credit of the operation and for the encouragement of other better candidates, the definitely bad risk must be excluded from operation until, at any rate, we learn how to reduce the strain of the procedure and make it more safe for those who can bear very little. By strict observance of this principle we can certainly reduce the operative mortality in favorable cases to 4 per cent and Sauerbruch has claimed a still lower mortality rate in this group. The operation of thoracoplasty on the tuberculous subject is still regarded by very many as a most formidable one to be advised only as a last resort. It is formidable in some types of the disease. But if, knowing the danger we exclude such types from operation, we can make it one of the least dangerous and most beneficent of all major operations.

#### DISCUSSION

DR CARL A. HEDBLÖM, Chicago. One of the chief difficulties inherent in evaluation and comparison of results of treatment in any field is lack of uniformity in the classification of types of cases and of results. There is a particular need for clear cut definition and uniform classification in the consideration of disease conditions having the wide range of variations as to pathology which is characteristic of tuberculosis. The surgical treatment of pulmonary tuberculosis is of relatively recent development and in the opinion of some is still on trial. It is important therefore to have a clear understanding as to types and the indications and results of treatment in each. It seems fitting that a classification meeting this need should come from the pioneer in the surgery of pulmonary tuberculosis on this continent. In my estimation Dr Archibald's classification merits careful study and general adoption.

I should like to add all possible emphasis to the statement that no other thing is so important as to realize that the essential difficulty lies in the judicious choice of the patient. This implies not operative skill—important as that is—but judgment based on knowledge of and clinical experience with pulmonary tuberculosis on the part of the physician, surgeon and roentgenologist in close collaboration. Injudicious choice of patients means poor results and unmerited discredit of a method of treatment based on sound principles and abundantly able to prove its worth.

The close relationship that exists between indications and results is shown strikingly by Dr Archibald's statistics. In his group of favorable cases 83 per cent were cured or greatly improved following thoracoplasty and the operative mortality was only 3.3 per cent whereas in the group classified as unfavorable only 33 per cent were improved and there were 38 per cent operative and 28 per cent non-operative deaths. In other words in the unfavorable group one third of the patients were improved while two thirds died.

Unerring pre-operative classification can be only approximated and as stated some unfavorable cases are operated upon to give them the benefit of the doubt. Every effort should be made, however, to eliminate this group. In my experience the preliminary pulmonary phrenic nerve operation has been of great value as a test operation. Some patients who seemed decidedly hopeless have been converted by it into cases favorable for thoracoplasty following which they have achieved a complete clinical cure. The benefits of this simple phrenic resection are sometimes most remarkable. In any case it adds to the rest and compression afforded by later thoracoplasty.

Generally speaking patients showing a rapidly progressive downward course are poorer risks than they appear at the moment while patients distinctly on the mend are more favorable than they seem. Patients reduced to a critical state by profuse hemoptyses are more favorable for thoracoplasty than they seem provided the operation is preceded by a transfusion of blood.

Time will permit only passing mention of tuberculous empyema. May I stress Dr Archibald's statement that every possible effort should be made to avoid secondary infection by tube drainage or rib resection? Mild mixed infection responds to needle aspiration. Bronchopleural fistulae are avoided by early obliteration of the pleural cavity. Posterior thoracoplasty followed by anterolateral costectomy will reduce the cavity to small proportions. If there is no secondary infection the residual cavity will usually become obliterated spontaneously. If there has been open drainage I always obliterate the persistent residual cavity by a pleural resection which is well tolerated.

Dr Archibald expresses the hope that the high mortality in the "poor risk" patient may be reduced by a three or four stage operation. I should like to

directed to the fact that in contrast to success of the regimen among patients who are in good condition, experience seems to show that cardiovascular disease or diseases of other parenchymatous organs which debilitate or weaken the patients predisposes to the formation of thrombi and emboli. One of the most important factors concerned probably in their production is the change in blood flow occurring simultaneously with decompensation of the function of these structures.

In the statistical review by Henderson of 313 cases of pulmonary embolism in The Mayo Clinic during the 10 year period from 1917 to 1927, there were 46 non surgical cases in which fatal embolism occurred. Half of these patients had myocardial degeneration with marked decompensation. In some of the non surgical cases, pulmonary emboli were found unexpectedly at necropsy, when death had appeared to be due to cardiac failure from myocardial degeneration, peritonitis, bronchitis, or hemorrhage, and embolism had come into the picture as a terminal event.

Kuhn, at the Institute of Pathology at Freiburg, recently reported that the incidence of fatal embolism in Germany from 1924 to 1927 increased from 1.3 to 4.9 per cent, whereas in 1927 thrombosis was found in every fourth body examined and fatal embolism was found in every twentieth body. He stated his belief that this increase in the incidence of thrombosis and embolism is the result of prolonging life by the treatment of patients with chronic disease of the heart. With such disease, changes in the flow of blood occur.

Further evidence of the tendency to the formation of thrombi and emboli in patients who are debilitated by disease is found in the fact that the incidence of fatal postoperative embolism was three times greater after cystostomy preliminary to prostatectomy on debilitated patients than after the same operation performed on patients in good condition. The effect of cardiovascular disease and disease of the parenchymatous organs as the predisposing and probably uncontrollable factor of pulmonary embolism has been emphasized because of the problem of compensating for these fixed pathological changes and because it emphasizes the influence of changes in

the flow of blood in the formation of such emboli.

In the series of 4,500 surgical cases which I am reporting, pulmonary emboli were found at necropsy in 4 cases, 3 of the patients were more than 70 years of age and had advanced cardiac disease. In 2 cases pulmonary emboli were found unexpectedly at postmortem examination, death was the result of uræmia in 1 case and of sepsis in the other. The other patient, a woman aged 54 years, had auricular fibrillation, and died on the sixth day following her operation. She had received only 4 grains of desiccated thyroid gland the preceding day.

Since mention has been made of the predisposition of elderly patients with debilitating disease to the formation of thrombi and emboli, especially in cases of cystostomy as a preliminary to prostatectomy, it is of interest that in this series of operations 779 were performed on the prostate gland and bladder, 273 of these patients were in too uncertain a condition to warrant primary prostatectomy and so cystostomy was performed. Of the 4 patients who died from embolism, 2 had had cystostomy as a preliminary to prostatectomy, both patients were more than 70 years of age.

#### METHOD OF REDUCING THE INCIDENCE OF POSTOPERATIVE EMBOLISM

In order to combat the decrease of metabolism, the decrease in blood pressure, and the slowing of circulation, tablets of desiccated thyroid gland in doses of 2 grains, administered 3 times daily, have been used in all cases except those in which there has been an abnormal increase in pulse rate and temperature occurring as a spontaneous postoperative reaction. Cases in which the desiccated thyroid gland is not given will comprise approximately 10 per cent of the total number. Inasmuch as the increase in temperature and pulse rate in this small group occurs spontaneously, which means an increase in metabolism and flow of blood, it has not been felt necessary to add further to the reaction by the administration of desiccated thyroid gland. The administration of desiccated gland is begun as soon after operation as the gastro intestinal tract tolerates fluids and drugs, usually from the second to the fourth days, and is continued until the



# A METHOD OF REDUCING THE INCIDENCE OF FATAL POSTOPERATIVE PULMONARY EMBOLISM

RESULTS OF ITS USE IN FOUR THOUSAND FIVE HUNDRED SURGICAL CASES<sup>1</sup>

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**C**LINICAL investigation has been, and should continue to be, a reliable method of securing information. We have but to review the work of Richard Bright on nephritis, that of Addison on tuberculosis of the suprarenal glands and on pernicious anemia, and the many recent advances in medicine developed by deduction from clinical observations substantiated by postmortem reports to appreciate the value of clinical investigation. Experimental investigation and research leading to deductions referable to clinical problems have so well justified themselves that unless deductions made from clinical investigation are proved to be facts by animal experimentation we may look on the results of such work as suggestive but not proved. Pulmonary embolism is one of the great surgical problems. Unfortunately up to the present time it has been difficult to produce pulmonary emboli experimentally in a manner which simulates their formation in human beings. In more than 60 experiments on animals Miller and Rogers were unable to produce pulmonary emboli that might be compared in formation and condition to emboli in human beings. The deductions which I am making in the presentation of this material are essentially the result of clinical investigation. Yet these investigations carried on over a period of 4½ years in a large group of cases have proved of great clinical value.

Many physiological changes and adjustments follow surgical procedures. Those seemingly concerned in the formation of postoperative pulmonary emboli are (1) decrease in metabolic activities, (2) the tendency toward a decrease in the rate of blood flow (pointed out by Virchow in 1846) with a decrease in blood pressure and (3) changes in the cellular constituents of the blood.

These conditions may be the result of (1) rest in bed without food, (2) interference with

circulation by intra abdominal manipulation (3) forty eight hours of intestinal quiet after intra abdominal operations, and (4) muscular splinting of the abdominal wall because of a painful incision.

Any method which would cause an increase in metabolism, in rate of the flow of blood and in blood pressure should decrease the incidence of fatal postoperative embolism. The metabolism can be increased effectually by the use of desiccated thyroid gland. Clinical support of the value of increased metabolism in the prevention of thrombosis and embolism is lent by Plummer's observation that in cases in which the thyroid gland is hyperfunctioning thrombosis and embolism practically never occur even when disturbances of blood flow are extreme from associated cardiac decompensation. In contrast to this is the frequent association of thrombosis and often fatal embolism in patients with primary cardiac decompensation. When 2 milligram of thyroxine was administered daily for 3 days to rabbits by Shonoja and Rowntree, thrombosis did not occur for from 25 to 30 minutes in contrast to thrombosis occurring in their control animals in from 4 to 10 minutes. This change in blood flow and the late formation of the thrombosis following thyroxine experimentally administered by them was sustained for 3 days.

The tragic deaths from pulmonary embolism are those occurring in patients who except for the lesion for which they are being operated on are in good condition. Most of the reported deaths from fatal pulmonary embolism have occurred in patients of this type, yet death did not occur among patients of this type in the series of 4500 surgical cases in which the method of prevention which I am presenting was used. Any method of reducing the incidence of postoperative pulmonary embolism should have its greatest possibility in this group of cases. Attention therefore, is

Fatal pulmonary embolism did not occur among patients in good general condition when the described regimen of prevention was carried out

## BIBLIOGRAPHY

- 1 HENDERSON E F Fatal pulmonary embolism statistical review Arch Surg 1927 xv 231-236
  - 2 JENN E S and WALTERS WALTMAN Abstract of the report of the surgical procedures on the gall bladder bile ducts liver, and pancreas for 1928 Proc Staff Meetings Mayo Clinic 1929 iv 165-167
  - 3 KURY J K Causes of increased incidence of thrombosis and embolism in Germany from 1924 to 1927 J Am M Ass 1929 xcvi 400
  - 4 MILLER R H and RODGERS HORATIO Postoperative phlebitis and embolism In press
  - 5 LOOT Quoted by Victor J A Clinical considerations of thrombosis and embolism Ann Surg 1925 lxxxii 193-198
  - 6 ROSENOW E C A bacteriological study of pulmonary embolism J Infect Dis 1927 xl 380-398
  - 7 SHONOYA, TAKUJI, and POWNTREE L G Method for direct observation of extracorporeal thrombus formation J Exper Med 1927 lvi 7-12
  - 8 WALTERS WALTMAN Suggested use of thyroid extract to reduce the incidence of postoperative embolism preliminary report Minnesota Med, 1927 x 25-28
  - 9 WILSON, L B Fatal postoperative embolism Ann Surg 1912 lvi 809-817
- The following additional references may be cited
- ALLEN E V Changes in the blood following operation Arch Surg 1927 xv 254-264
- BARRETT W D Thrombosis and embolism Canad M Ass J 1914 xiv 119-132
- BROWN G E Postoperative phlebitis clinical study Arch Surg 1927 xv 245-253
- CONSTON C G Pulmonary embolus following operative interferences Boston M & S J 1908 cliii 281-287
- FENLEY F G Mitral stenosis with venous thrombosis Med Clin N Am 1913-1924 vii 1907-1912
- GAGER L T Blood pressure changes accompanying coronary occlusion J Am M Ass 1925 lxxiv 1730-1737
- GIBSON C L Pulmonary embolism following operation Med Rec 1909 lxxv 45-47
- GREENBERG DAVID Clinical studies in venous thrombosis Med J & Rec 1924 cxx 276-278
- HEARD J E I Postoperative pulmonary embolism New Orleans M & S J 1924 lxxvi 451-459
- LOCKHART MUMFERY J F Postoperative pulmonary embolism Brit M J 1924 ii 184-185
- MANN F C Pulmonary embolism J Exper M 1917 xvi 357-363
- SMELL, A M Relation of obesity to fatal postoperative pulmonary embolism Arch Surg 1927 xv 237-244
- WALTERS WALTMAN Reducing postoperative pulmonary embolism Surg Gynec & Obst 1927 xlv 238-239

## DISCUSSION

DR EDWIN M MILLER Chicago The endeavor of the essayist in this piece of clinical research is worthy of commendation for though the incidence of fatal postoperative pulmonary embolism is relatively small the fact that the accident usually happens with such frightful suddenness and with such surprising unexpectedness, often at a time

when the patient is well on the way to recovery would make any well defined program directed toward its elimination or even reduction in frequency, more than welcome We have heard presented such a method, adequately tested and of proved value Nothing, it would seem on the face of it, should stand in the way of its acceptance

General acceptance however, of any new therapeutic measure no matter how attractively presented seldom is quickly gained, because first must be overcome a natural reluctance due partly to lack of knowledge of the new procedure and partly to faith in existing methods a frame of mind which stimulates one to investigate all phases of the proposition before being convinced of its merit

What are the facts surrounding cases in which a fatal pulmonary embolism has followed an operation? From a review of reports published within the past few years especially from the German clinics, and from information received directly from pathologists the following statements may be made without reservation

- 1 The incidence of proved cases is very small
- 2 The majority of the patients are well advanced in years usually above the age of 60
- 3 The operation is usually on the midportion of the body especially the lower abdomen or pelvis
- 4 The pathological condition is very frequently a carcinoma
- 5 The accident is most apt to occur during the convalescent period without pre-existing edema, swelling of the legs thrombophlebitis or any other clinical sign which would attract the attention of the clinician to a likelihood of its occurrence
- 6 At autopsy the site of origin of the thrombus is almost always found to be in the iliac or pelvic veins or right auricular appendage The length, caliber and shape of the clot are sometimes the only clues to its origin, because of the almost constant absence of any local inflammatory change in the endothelial lining at the original site
- 7 After giving due consideration to the influence of the multitude of factors which may or may not contribute to the etiology the outstanding single factor concerned is stasis of the blood in the large veins of the pelvis

What then may be done to influence this situation? Certainly much may be accomplished by methods already at our disposal (a) careful preoperative study of each case especially in those of advanced years, providing aid through digitalis to a weak or failing circulation (b) careful operative technique—clean cut dissections accurate hemostasis and avoidance of mass ligation and undue pressure on great veins by retraction and (c) diligent postoperative care the paying of particular attention to adequate fluid intake, and intelligent use of digitalis caffeine or other drugs acting directly on the circulation Tight bandages should be avoided and especially should the free mobility of the chest be preserved Frequent change in the position of the patient the encouragement of early systematic exercise

patient is out of bed usually the tenth day. In any event the administration of the gland is stopped by the twelfth day. If marked elevation of pulse rate and temperature occur it is discontinued sooner. In 3 cases compound solution of iodine (Lugol's solution) was given to counteract its effect, which it did successfully and without harm to the patient.

Since an increase in metabolism which also may mean an increase in both temperature and pulse rate, is the primary object of giving the desiccated gland, it cannot be considered a deleterious effect. Other untoward effects have not been noted. If, during its administration, the patient is nauseated or vomits, it is discontinued. Also patients have been urged to move in bed to flex their legs and arms and especially to turn themselves from side to side, as advised by Wilson and Pool. Not infrequently even on a surgical service in which such a regimen is considered a routine procedure, one may find an occasional patient who during the surgeon's absence has not moved from the position in bed in which he was placed when he returned from the operating room or who has not received the desiccated thyroid gland. This emphasizes the necessity in each case of the surgeon seeing to it that whatever regimen is outlined should be carried out for if this is relegated to others its importance may not be recognized. Such a regimen has been used during the last  $4\frac{1}{2}$  years in the management of 4,500 surgical cases on my service, consisting for the most part of intra abdominal operations on the gastro intestinal, the biliary, and the genito urinary tracts.

The method of reducing the incidence of fatal postoperative embolism described might be expected to have a field of application in all cases except those of elderly patients with marked cardiovascular disease or disease of other parenchymatous organs which has weakened and debilitated the patient. On the surgical service of my colleague, C. F. Dixon this regimen has been followed in all cases (except cases of hyperthyroidism) during the last 2 years, without a death from postoperative pulmonary embolism.

Undoubtedly there are factors other than slowing of the rate of metabolism, lowering of

blood pressure, and possible retardation of the circulation that are responsible for the formation of thrombi and emboli else the incidence of postoperative embolism would be much higher. It seems reasonable, however, that they set the stage, and whether infection, as may be inferred from Rosenow's isolation of streptococci from emboli at necropsy, or changes in blood or tissue fluids are the exciting factors is as yet undetermined. However, lowering of blood pressure, depression of metabolism, and possibly slowing of the circulation as a result of prolonged rest in bed, with great diminution of peristalsis and the restricted excursion of the diaphragm following operation play an important part in either the predisposition to, or the causation of postoperative thrombosis and embolism. Attempts have been made to overcome these changes through increasing the metabolic rate by the use of tablets of desiccated thyroid gland and early movement of the patient in bed.

#### SUMMARY

In a study of 267 cases of fatal pulmonary embolism following 63,347 major operations during the 10-year period from 1917 to 1927 at The Mayo Clinic, Henderson found the average incidence of fatal postoperative embolism to be 0.34 per cent.

The use of a regimen directed toward increasing the rate of metabolism, of blood pressure and of blood flow in 4,500 major surgical procedures of comparable type during the last  $4\frac{1}{2}$  years has been followed by an incidence of fatal pulmonary embolism in less than 0.09 per cent of cases.

Of the 4 patients in this series who had pulmonary emboli 3 were aged 70 years or more and of those 2 died from other causes (sepsis in 1 case and uremia in the other). The age of the third patient was 54 years and in this case auricular fibrillation was present. In each of the 4 cases there was myocarditis at necropsy, it was marked and associated with coronary sclerosis in 3 cases. These 4 cases illustrate the predisposition of patients with cardiovascular disease to the development of postoperative emboli, and emphasize the part played by disturbances of the blood flow in their formation.

addition to the injury of the intima of the veins, the blood stream is also slowed

The third contributing factor, and possibly the most important, is the change taking place in the blood itself after operations especially after operations on patients who are aged who have cancer, who have cardiovascular disease, or who have recently undergone severe general infection Bancroft and his collaborators have shown after careful blood studies that patients with postoperative thrombosis and embolism have an increase of blood clotting factors in their blood and usually a diminished amount of anti thrombin Govaerts at the International Surgical Congress this past summer advanced the interesting theory that injury to the blood platelets with their consequent viscosity brought about by infection was a primary cause of postoperative thrombosis He said it was a common finding to recover micro organisms from the clot causing the embolism

Martin recently published the results of some interesting experimental work on postoperative embolism He created emboli by the injection of iron chloride intravenously and watched under X ray the thrombus proceed to the lung Its course was slow and vacillating through the vena cava and occasionally it passed backward against the blood stream When it reached the region of the diaphragm, it shot forward into the heart, aided by the sucking action of the accessory movements of respiration From his study he believed that thrombi which did not occlude the vein or which reached beyond their point of vessel wall attachment into a larger vein were most apt to be detached and become emboli

*Prevention* Until more definite facts are known concerning the mechanics and chemistry of blood coagulation our efforts must be aimed at removal of factors which predispose to thrombosis

Before operation the patient should be out of bed as much as possible and fluid should be taken freely on the days preceding the operation Purges *preceding the operation* with their consequent loss of body fluid should be avoided If there is any question about the strength of the heart, digitalis should be given, but intravenous medication should be avoided Varicosities of the extremities should be lightly bandaged with bias cut flannel bands

At the operation, extreme care should be taken to avoid loss of blood and trauma, such as mass ligatures Heavy mechanical retractors should be avoided

*Postoperative procedure* The patient should not be allowed to remain in one position during the first few days when so little inclination exists to move The position of the legs should be frequently changed, and in almost all abdominal surgery the patient should be turned on the side for certain periods during the day Tight abdominal dressings should be avoided The fluid content of the bowel should be maintained Heart stimulants should be used where cardiovascular incompetence is suspected In accordance with the recommendation of Walter and Frund small doses of thyroid extract may be given

#### BIBLIOGRAPHY

- MARTIN Arch f klin Chir clv 377  
 TEMPSKY Beitrag z klin Chir cxliv, 179  
 FRUND 7 org Chir xlv 118  
 GOVAERTS Presse med No 66 1972  
 BANCROFT Quoted by Kugelman and Brown Ann Surg, xc 161  
 ASHOFF Arch f path Anat etc Beil cxix  
 MARTIN Arch f klin Chir clv 495  
 BAUER Zentralbl f Chir 19 9 No 27 1620  
 BORCHARD Beitr z klin Chir cxliv 161  
 PETERING Beitr z klin Chir cxliv 416  
 LUBARSCH Hxematologica b-v

of the arms and legs, and especially daily elevation of the foot of the bed as a mechanical method of increasing the venous flow from the dependent pelvic region, are important in the prevention of stasis of the blood.

It is a question in my mind whether, having done these things in the hope of avoiding a fatal pulmonary embolism much more would be accomplished by the use of thyroid extract unless it is definitely shown that on account of the slight rise in metabolism which follows the rate of flow is accelerated or the pressure elevated in the great veins of the pelvis which are most commonly the original site of the thrombus.

**DR VERNON C DAVID Chicago** While an average of from 1 to 3 instances of postoperative pulmonary embolism usually occurs in large clinics in every 1000 cases operated upon there seems to have been a decided increase during the last few years. This may be more apparent than real, as Detering of Frangenheim's Clinic has pointed out, for in a chart covering the incidence of embolism since 1900 in the Cologne Clinic there was seen to be nearly as marked an increase in 1909 as there has been in the last few years. However between the years 1923 and 1926 there has been a threefold increase in postoperative pulmonary embolism in Schmieden's Clinic and this is typical of many other clinics including those of Rost and Bier. Concurrent with this has been the relative increase of thrombosis in patients after operation. Fatal embolism in non-operative cases and in medical cases also has increased during the same period but not as rapidly. In 30000 cases in the Chemnitz Clinic Martini reports an incidence of 0.22 per cent fatal postoperative embolism from 1917 to 1928 while 0.1 per cent occurred in patients who were not operated upon.

**Clinical details.** The usual time of appearance of postoperative embolism has been between the sixth and tenth days after operation. The majority of instances occurred in patients between 50 and 70 years of age. Obesity seems to be a predisposing factor. The type of anesthesia seems to have no causative relation. In some statistics cancer was present in as many as 33 per cent of the patients. Preceding infection such as influenza or typhoid, is commonly present in the antecedent history.

The type of operation seems to play an important predisposing rôle in postoperative embolism. Abdominal and pelvic surgery leads the list in about 70 per cent of the cases. Stomach surgery especially for cancer of the stomach and pelvic surgery, particularly operations for prostatic hypertrophy and fibroids of the uterus are the most important. Gall bladder surgery and surgery of the large bowel including removal of the appendix also are followed by fatal embolism. Hernias too play rôles while surgery of the extremities is rarely complicated by embolism. Thyroid surgery is particularly free from postoperative embolism. It is of interest in this

connection that Frund from the Garre Clinic has reported a decrease in the number of postoperative emboli following the administration of thyroid extract to patients about to be operated upon.

Tempsky tabulated a series of operations for carcinoma of the stomach, carcinoma of the rectum and appendicitis, from the Kuttner Clinic in relation to postoperative thrombosis and embolism. In 1438 cases of carcinoma of the stomach there were 41 postoperative thrombi and 12 emboli. In 496 of these cases resection of the stomach was done with 17 postoperative thrombi and 5 emboli which is at the rate of 1 embolism in every 100 cases.

In 506 cases of carcinoma of the rectum there were 27 postoperative thrombi and 17 emboli. Of these cases, 304 resections of the rectum were performed with 23 postoperative thrombi and 12 emboli or nearly 5 to every 100 cases.

Contrasting sharply with this was the report of 1767 cases of appendicitis in which there were 29 thrombi and 4 emboli or 2 to a thousand, which is about the usual rate.

**Pathological anatomical considerations.** While visible peripheral thromboses of the internal saphenous vein are most common fatal postoperative emboli rarely originate from this source as it is found that 50 per cent of postoperative pulmonary emboli have their source in the femoral or iliac veins (Lubarsch). While occasional thrombosis of these veins may occur because of direct trauma from a mass ligature or from the direct action of an infectious process in most instances these veins are not in the immediate operative field. The underlying cause of thrombosis must be discovered in factors not purely obvious.

Of these the importance of slowing of the circulation in veins has been emphasized by Ashoff and his school as an important factor predisposing to thrombosis. The platelets and white blood cells linger in the periphery of the vessel where the stream is the slowest and lay down on the endothelium of the vessel a white coagulum from which a thrombus starts. The factors influencing slowing of the blood stream in the large veins occur not infrequently in surgical patients. Among the most important of these factors are loss of blood, shock, loss of fluids from catharsis or excessive perspiration, weak heart action and interference with the action of respiratory movements due to the pain of abdominal incisions. Of all the cases having postoperative embolism Bauer from Koenig's clinic stated that about one fourth were noted to have cardiovascular lesions before operation but that at autopsy the heart was found to be affected in 95 per cent.

Ribbert has emphasized the importance of injury to the intima of the blood vessels in promoting thrombosis. Endothelium occurring in any of the structures of the body including the veins is subject to injury and degenerative changes by reason of infections, toxins from cancer growth, injury from the use of intravenous medication and many other agents. Thrombosis is especially likely to occur where in



Fig. 1 Photograph of capsular surface of tumor. Contour disturbed by bisecting.



Fig. 2 Cut surface of the tumor. Actual size and shape. Texture quite well shown.

bands. It was firm, smooth elastic and gave to the palpating fingers the sensation of a tense cyst. Figure 1 is a photograph of the capsular surface of the tumor. The contour was disturbed somewhat by bisecting the tumor before this photograph was taken. Figure 2, which is reproduced from a painting of the cut surface of the tumor, shows the shape of the tumor better and the texture also.

#### MICROSCOPIC PATHOLOGY

Half of the tumor was sent to Dr. J. Ewing of New York and half to the pathologist of St. Joseph's Hospital. Dr. Ewing reported as follows:

The tumor which you sent me proves on section to be an alveolar carcinoma. The main features suggest the diagnosis of adrenal adenocarcinoma. The cells are quite opaque and they form small rather regular alveoli (Fig. 3). There are no traces of pigment so that the tumor is probably an adrenal cortical tumor. The structure is not unlike that of the renal cortex but the fact that there are

no lumina shows that it is not a renal tumor. Although the tumor was well encapsulated (Fig. 4) and not of large size, I think it is malignant. There are many large blood sinuses through which the tumor cells might well produce metastases. Yet all these sinuses are intact and it seems quite probable that no metastases have occurred.

The hospital pathologist's report was as follows:

The specimen was brought to the laboratory on June 26, 1929. Microscopic study of sections from various parts of the tumor mass shows an extensive hyperplasia and overgrowth of the cortical tissue of the adrenal, especially the zona glomerulosa, extending from the capsule down for about 1 to 2 inches. The histologic architecture is that of numerous broad sheets of cells without any alveolar

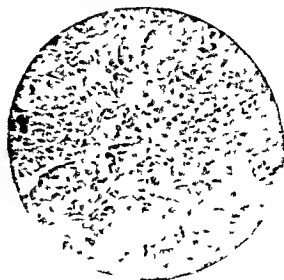


Fig. 3 High power photomicrograph of adrenal tumor removed.

TABLE I—BLOOD PRESSURE READINGS DURING OPERATION

Time	Systolic pressure	Time	Systolic pressure	Time	Systolic pressure
8:30	110	8:55	225	9:17	110
8:35	110	8:57	230	9:18	125
8:40	110*	8:59	222	9:22	114
8:41	140	9:01	215	9:23	112
8:42	152	9:02½	225½	9:24	110
8:42½	160	9:06	145½	9:26	90
8:43½	153	9:07½	157	9:28	88
8:45	184	9:09	174	9:30	96
8:46½	222	9:11	218	9:43	80
8:48	262	9:13	212	9:44	78½
8:49	264	9:14	206½	9:45½	82
8:53	260	9:16	162	9:48	86
8:54	262				

\* Patient cyanotic.

½ gram morphine sulfate administered.

1 ccm. digitalin administered.

† Tumor removed.

‡ Adrenalin administered.

# REPORT OF A CASE OF PAROXYSMAL HYPERTENSION CURED BY REMOVAL OF AN ADRENAL TUMOR<sup>1</sup>

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**T**HE patient, L. W. H., male, aged 39 years, married but without issue, reported first in May, 1927, complaining of peculiar attacks, occurring apparently without reason or warning which had begun in February, 1927. Most of these attacks had, up to this time, occurred while he was in bed, and they were accompanied by an unpleasant sensation in the epigastrium, similar to, but not exactly, nausea. At this time they were of short duration, probably 30 or 40 seconds, and passed off without other definite symptoms. His color during the attack was said to be "sickly green."

His past history as well as his family history, contained nothing worthy of comment. Except for the period of the attacks he "felt fine."

Complete physical and laboratory examinations revealed negative results except for white blood cells of 14,000 and slightly increased eosinophiles 12.5 per cent and a maximum systolic pressure consistently near 120. Urinalysis complete X-ray examination duodenal drainage liver and kidney functional tests all were negative.

From that time on, except for short periods one lasting 30 days but most lasting only 4 or 5 days these spells recurred similarly. Gradually the patient began to notice that assuming certain positions especially one of slight inclination forward and to the left would bring them on. It became possible then to produce them at will and make it possible to examine him during such an attack.

Within a few minutes after assuming the position he complained of the peculiar sensation his maximum systolic pressure would rise from 110 to 200 or more within a period of 90 seconds and his heart slowed down to about 55 showing an unusually forcible beat sufficient to shake the bed or chair he was occupying. His color was ashen and he felt "terrible." This condition rarely lasted over 3 or 4 minutes the pressure dropped as rapidly as it had risen and within 10 or 15 minutes he felt as well as ever.

Continued observation revealed nothing new. The white count varied from 14,000 to 20,000 with a persistent moderate eosinophilia. As the months passed mild renal degenerative signs gradually manifested themselves. In addition mild cardiac embarrassment was noticed shown by slight dyspnea on exertion occasional tendency to tachycardia following the attacks and a very greatly increased period of disability and discomfort following the periods of hypertension.

Consultation with several eminent specialists revealed nothing further and nothing any more definite than what has been already cited.

Accordingly, in view of the analogous cases reported by French clinics Dr. Charles Mayo Dr. Shipley, and others it was felt that the diagnosis obtained by a process of elimination of possible adrenal or chromaffin cell tumor was sufficient ground for an exploratory laparotomy. Ready acquiescence on the part of the patient was forthcoming because he felt he was growing worse.

The strikingly paroxysmal character of the attacks and their short duration made it reasonably certain that the afflicting source was operating through the autonomic nervous system and no other source could be suggested than an adrenal or chromaffin origin.

## OPERATION

On June 19, 1929 a vertical midline epigastric incision was made. Nothing abnormal was discovered on the left side but on the right side a globular tumor occupying the right renal region was found and first mistaken for an abnormal shaped kidney. On further examination the kidney was outlined a little below and behind the tumor which was slightly movable and retroperitoneal.

A transverse incision was made to connect with the vertical incision for better exposure of the tumor. The peritoneum was incised and the tumor removed with little difficulty and without much hemorrhage although it had attached to it numerous very vascular loose connective tissue bands all of which were ligated save a posterior one which held the tumor rather close to the back. This was clamped and the clamp allowed to remain for 45 hours when it was removed without incident. The tumor had no pedicle and was completely encapsulated. The wound was closed around the forceps and a gauze drain protected by rubber dam.

The operation was begun at 8:30 and ended at 10:25. Administration of the anæsthetic was started at 8:15 and stopped at 9:30.

The patient was put to bed in a state of severe shock which in spite of active medication continued for more than 24 hours. Twenty-four hours after the operation the blood pressure was 80-85 but the next day it had risen to 110 and the next to 145. All medication was discontinued after the eleventh day and the patient left the hospital on the fifteenth day. He has had no attacks during the 74 days since the operation can lie on his left side with comfort and has resumed his work.

The tumor was found to be quite regularly spherical in shape with a distinct perfect capsule to which were attached numerous vascular tissue

LAWS OF CELL GROWTH<sup>1</sup>

CHARLES H. MAYO, M.D., ROCHESTER, MINNESOTA

THE study of cell growth is most interesting, as is the study of all that is connected with the function of cells, namely, maturity, degeneration, and death. Disintegrative bacteria, as single cell chemists, were the first industrial workers, they split and respit the inorganic elements making new combinations of the world's material. The one essential material was the chlorophyll in the cell which made active microbial life possible and, ultimately, multicellular life. Single cell life growing by division of the cell into two cells, under the influence of food and environment, is a normal process and continues thus indefinitely. These chemists prepared the way for higher types of active single cells to live on the organic material, which was accomplished when chlorophyll appeared. Cell growth is possible because the permeability of the cell membrane allows the cell to receive food; the single cells assimilate the food and eliminate waste products. They multiply indefinitely with food and favorable environment. Cell growth lags at times to start anew with an added drop of the original culture or by some change in fluid or cells developed by the rest period.

Recent work in the field of vitamins has disclosed the existence of significant relationships between various vitamins and processes of growth. Evans and his co-workers have shown the necessity for a fat soluble vitamin I for reproduction. Vitamin B has been shown essential for proper lactation, and the hormones of the gonads are known to be essential for normal development. All these results indicate that, although the nervous system may effect a proper relation of various organs still the essential controlling mechanism in growth appears to depend on the presence of various vitamins and the products of the various ductless glands.

The great animals of past ages, both invertebrate and vertebrate, possibly lacked the control of cell growth and size, one factor which caused them to perish from the earth.

The blue whale of today, 90 feet long and 150,000 pounds in weight has survived in the sea and is now the largest living animal. When the more advanced life of multicellular structures developed, the granules which had controlled the large single cell organisms became assembled into different organs for the general control of the body, making community cell life possible. The secretion of the cells then passed into the intestine to prepare nourishment or was delivered into the blood, by absorption or through lymphatic vessels, to act as fluid nerve hormones. They may be amplified by sympathetic ganglions with nerve connections causing change in the general circulation, the internal organs, or other regions of the body. At the present time, following ages of trial and adjustment, there is an average size to cells of both plants and animals. The laws of growth, with normal conditions, give an average size for all structures and organs made up of cells. The limitation of growth is a factor seldom considered except in the presence of cretinism, of gigantism, or of local overgrowth.

Riddle, at the thirteenth annual meeting of the Association for the Study of Internal Secretions held in Portland, Oregon, July 9, 1929, expressed the conviction that growth in the animal organism, in particular intra-uterine growth, is not under the control of the nervous system, but that it is controlled by the ductless glands. Robertson has shown that growth progresses in definite cycles with various stages of retardation, which, when plotted, form a series of steps. P. E. Smith, by removal of the pituitary gland in the tadpole, showed that metamorphosis was prevented. The tadpoles grew to a very large size, but remained in the tadpole form. The administration of thyroid preparation at any time induced metamorphosis, but the thyroid gland of the hypophysectomized tadpole was in a quiescent state and did not appear to possess the power of activity. In 1919 Uhlenhuth suggested that the mechanism of

<sup>1</sup>Presented before the Clinical Congress of the American College of Surgeons, Chicago, Oct. 14-15, 1929.



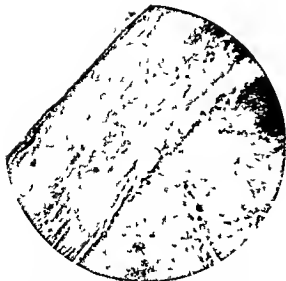


Fig 4 Low power photomicrograph of adrenal tumor removed

formation. The cells are arranged in small circular groups separated by fine strands of connective tissue. This arrangement of the cellular elements is uniform from the capsule down. The histological picture of the specimen is that of a neoplasm known variously as adrenal hypernephroma, Grawitz tumor or adrenal adenoma.

Prior to the present, 7 cases of paroxysmal hypertension have been reported including 5 from Europe and 2 in this country. In 1 case the lesion was nasopharyngeal, in 1 case it was mediastinal, 1 case was due to a tumor like the one herewith reported, there was 1 case in which the etiology was not definitely determined, 1 case was due to meningococcus meningitis, and 1 was a paraganglioma. The case reported in the paper was an adrenal adenocarcinoma. It is worthy of note that of

these 8 tumors causing paroxysmal hypertension, 5—possibly 6—were malignant. Another noteworthy fact is that 7 of these tumors were remote from the adrenal glands, 1 e above the diaphragm.

It would seem that tumors of the chromaffin organs in any situation may cause paroxysmal hypertension. So far as can be learned, in only 2 cases, that reported by Dr Shipley and the one reported in this paper were diagnoses made before operation. Malignant invasion of glands usually results in hypofunction rather than hyperfunction, but the reverse would seem to be the rule in chromaffin cell tumors.

#### BIBLIOGRAPHY

- 1 BERDEZ Arch de med exper et anat path 189 IV 414
- 2 DONZELOT E The clinical modalities of paroxysmal arterial hypertension Paris méd 19 8 lux 19 1
- 3 HARVEY P and BARIETY M Bull et mém Soc méd d hôp de Par 1923 176-181
- 4 LABBE M TENEJ J and DOUTIER Bull et mém Soc méd d hôp de Par 1922 987-990
- 5 LAUBRY M CH Bull et mém Soc méd d hôp de Par 1927 VII 1216-1227
- 6 MAIO C H Collected Papers Mayo Clinic 19 1 X 732
- 7 NEUBERG Nothnagel's Spec Path u Therap 1898 XVIII 71
- 8 ORERLING C and JUNG Bull et mém Soc méd d hôp de Par 19 21v 98
- 9 OPPENHEIMER B S and FISHER ARTHUR M The association of hypertension with suprarenal tumors Arch Int Med 19 4 XXXIV 631
- 10 RABEN COLEMAN B Chromaffin cell tumor of the suprarenal medulla (pheochromocytoma) Arch Path 1929 VII 28
- 11 SHIPLEY ARTHUR Ann Surg In press
- 12 VAQUEZ Tr Cong franc de méd 1904 p 313
- 13 VAQUEZ and DONZELOT Presse med 19 6 13 9
- 14 VILLARET M BLOCH S BARIETY M and LAPPAS B J Presse med 19 6 11 836
- 15 WEBER C Paroxysmal hypertension due to subacute meningitis Arch de mal du cœur 1927 XX 598

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Destroying the so called grandad wart destroys the focus and all the other warts. Local deposits of special bacteria in a mucous membrane base may cause polyps or papillomata, as in the mouth, larynx, rectum, bladder, or renal pelvis. Larger areas within the uterus cause endometritis, or in the bowel typhoid fever exfoliation, as in colitis or polyposis. Undoubtedly, many carcinomata of the mucous membrane are secondary to local irritation of small growths. The irritation may have varied causes, as the condition is understood today.

The oldest living cells in the world are such cells as those in the giant trees of California three thousand to thirty five hundred years old.

The average length of life is increased, yet in the past ages individual men lived just as long as they do today.

The cells have then, a period of growth under control, maturity, and senescence which terminates in death. Sir John Bland Sutton said that at death of persons 90 or more years of age a very high percentage of carcinoma should be found by a careful search. Years ago I wondered at Cohnheim's theory of tumors developing from misplaced embryonic cells. These tumors have one of the essential conditions of cell division—stimulus from non-function. With growth started all the results of their oxidation go to cell division. The cell division occurs in the non functioning cell with less cytoplasm about the nucleus than that of normal cells. This makes the nucleus look proportionally larger. Such conditions are essential to cancer.

The number of unsuspected symptomless carcinomata found in carefully made necropsies is surprisingly high but with poor circulation abnormal change in harder and less active cells is slow to start and remains long a local condition, as in the aged. This makes doubtful the value of chemical reactions of the blood, such as we had hoped would enable us



Fig 2 Rose gall

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Like a heat regulator, we have a definite control of cell growth, also of the numbers of



Fig. 1. Growths on grape leaf caused by sting of phylloxera

metamorphosis involved the thyroid gland and another substance which acted as an excretory material and induced the gland to pour out its secretion, thereby producing metamorphosis. In 1929, Schwartzbach and Uhlenhuth showed that the anterior lobe of the pituitary gland is the source of the excretory substance. The thyroid gland can be stimulated by the administration of this substance. These results explain Smith's observations that the removal of the pituitary gland resulted in loss of activity of the thyroid gland and prevented metamorphosis. The administration of extracts of the anterior lobe of the pituitary gland produces gigantism. It would seem, therefore, that the pituitary and the thyroid glands have a controlling influence on certain phases of growth.

The cretin is a child or an adult person who was born without a working thyroid gland, a small, square headed, dry skinned unintelligent human animal who, if fed thyroid gland or its active principle thyroxine, during the early years of life will grow both mentally and physically. Myxedema is the condition which develops in persons whose thyroid glands have become inactive in adult life. *Oversecretion*

of the posterior lobe of the pituitary gland causes delay in the development of sex structures, with a continuation of the infantile period of life, whereas local or general overgrowth of the body is associated with changes in the anterior lobe of the pituitary gland. This region of the gland apparently stimulates the thyroid gland to activity.

The first crossing of selected stocks of cattle of long heredity, like the Aberdeen Angus bull with the Holstein, increases the rapidity of growth and weight over either type during the first 15 months of life. The first crossing of Rhode Island red chickens with barred Plymouth Rock chickens gives more rapidly growing progeny, with greater weight and greater egg fertility. This is true, also, of growth with artificial cross fertilizing of fruits and berries. The condition is maintained by planting grafted stock. Burbank proved this by his development of cross fertilization.

Overuse increases muscular development, and hypertrophy results. Intermittent pressure develops overgrowth of bone, as seen in bunions. The epithelium of the hands and feet, by rough wear, produces calluses as additional protective layers of cells are formed. The demands of the body for the function of certain organs cause hyperplasia of the cells. Thus, iodine deficiency changes the thyroid gland to a hyperplastic gland. The liver, also, through demands of the body as a stimulus, has great power of regeneration. If 70 per cent of a dog's liver is removed it will regenerate in 8 weeks, the growth being from the remaining part not from the new. The uterine muscle undergoes a great increase during pregnancy, which is caused by the chemical reactions of pregnancy. Whether the pregnant ovum is in the uterine cavity or in the tube or has slipped out into the abdomen.

Beginning 3 years ago, for a period of 2 years when a uterus containing fibromyomata was removed, the portion containing small tumors was sent to Rosenow, who made cultures of the crushed and ground tissue and secured bacterial growths of diplococci in 60 per cent of the specimens. In the uterine muscle a clump or colony of such bacteria the chemical product of which locally resembles that of pregnancy, causes the development of

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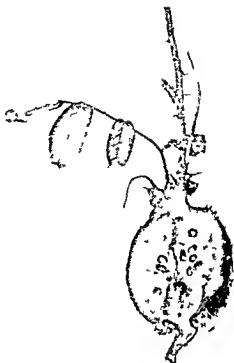


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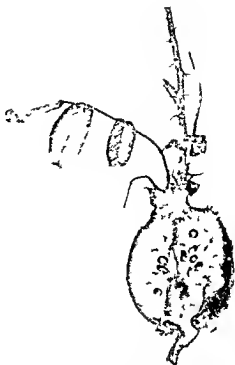


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red and of white blood cells, of the quantity of blood and of the calcium and blood glucose. An increase or decrease of these normal blood constituents constitutes ill health which may not be early appreciated.

# BIBLIOGRAPHY

- 1 EVANS H V The relations between fertility and nutrition. Lectures on Nutrition. Mayo Foundation. Lectures Philadelphia W B Saunders Co 1924-19 209-234
- 2 RIDDLE OSCAR Endocrine regulation of reproduction. Presented at the thirteenth annual meeting of the Association for the Study of Internal Secretions. Portland Oregon July 9 1929
- 3 ROBERTSON T B The analysis of the growth of the normal white mouse into its constituent processes. J Gen Physiol 1925-19 8 viii 463-50,
- 4 SCHWARTZBACH S S and UHLENMUTH EDWARD Anterior lobe, the thyroid stimulator. I. Basal metabolism. Proc Soc Exper Biol & Med 19 9 xiv 350-390
- 5 SMITH E F An introduction to Bacterial Diseases of Plants. Philadelphia W B Saunders Co 19 0 473-477
- 6 SMITH F E The effect of hypophysectomy in the early embryo upon the growth and development of the frog. Anat Rec 1916 11 57-64. Experimental ablation of the hypophysis in the frog embryo. Science 1916 xlii 280-283
- 7 UHLENMUTH EDWARD Relation between thyroid gland metamorphosis and growth. J Gen Physiol 1919 1 473-482

THE TONSILS AND SOME EXPERIENCES OF THEIR SURGICAL TREATMENT<sup>1</sup>

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 Sen or Surgeon Royal Ear and Throat Hospital (University College Hospital)

IT may seem strange to you that having been given the whole field of otorhino-laryngology from which to choose a subject for my address, I should select one so commonplace, threadbare, and even risky as anything to do with the tonsils. I say "risky" because one might visualize many of your fellows bringing their own self designed and fool proof guillotine "which enucleates the tonsil complete in its capsule" and, needless to add, the operation would be a bloodless one. Since my arrival in your hospitable country, I have heard used the term "tonsil kings" but no definition of this human species having been forthcoming. I have had to draw my own conclusions. If any such potentates be here today, I must ask their forgiveness if the mechanical aspect of tonsil surgery finds little place within the compass of my short address.

## AN ANATOMICAL MISNOMER

The term "supratonsillar fossa" is often used when matters connected with the tonsils are being discussed. Since that potential space is lined with epithelium, contains more or less loose lymphoid tissue, and is within the capsule of the tonsil, it would be more correct if we dropped the Latin prefix and simply spoke of the "tonsillar fossa."

## SOME SURGICAL ASPECTS OF DEVELOPMENTAL ANOMALIES

On occasion some developmental anomalies may become surgically important, and probably there are several of you here who have been hindered during a tonsil operation by an unduly long and ossified stylohyoid ligament. I have not known it to prove a serious complication because by separating and pushing outward the surrounding gland and connective tissues the projecting bony spine can easily be divided with forceps and removed.

Less commonly we may meet with the isolated spicules of bone or cartilage. The

large majority of these are, in the opinion of the late Professor S. G. Shattock, embryonic "rests" of the branchial arches.

I would like to take this opportunity of showing you a unique specimen of a bony tumor or "osteoma" which bulged forward the left soft palate and invaded the corresponding tonsil so that only a small portion of this remained in the lower end of its recess.

I saw the patient when she was 5 years of age and it was agreed to wait until she was older before attempting its removal. I did not see her again for 25 years, when she consulted me because the tumor was ulcerating through the soft palate and by scraping the side of the tongue made it sore. A crucial incision over the area of ulceration and separation of the surrounding soft tissues allowed easy enucleation of the osteoma. It was as large as a walnut and measured  $1\frac{1}{2}$  inches in its long diameter.

Its pressure on the cartilaginous portion of the eustachian tube had destroyed the median half of that structure without producing any ear symptoms. So rare was such a specimen that not even Sir John Bland Sutton, with his unrivaled experience of developmental curiosities, had seen anything like it, and the late Mr. Howard Mummary at first glance thought it suggested an odontome. He ground down many sections and reported that it contained no dentine but that sections of its fibrous capsule showed the presence of bone and cartilage deposits.

Professor Shattock then carried out a long and patient research on the nature of the tumor and his full and admirable report on it you will find in the *Journal of Laryngology and Otology* for April, 1924. It was included there by Dr. Irwin Moore in his exhaustive contribution on "Osseous and Cartilaginous Formations in the Tonsil."

It will suffice now to say that the tumor was composed almost entirely of compact bone.

<sup>1</sup>Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 24-28, 1929.



## TONSILLAR CALCULI

Although tonsillar calculi are neither osseous nor cartilaginous in structure, one may refer to them before passing to other matters, because attention has just been drawn to the occasional presence of bone and cartilage in tonsils.

Calculi may vary in size from that of a millet seed to that of a bantam's egg and may weigh as much as 1 ounce. Their composition is mainly phosphate and carbonate of lime and magnesia.

They may cause pain in the tonsil on deglutition and tend to produce attacks of tonsillitis, but my reason for mentioning them at all is this: if a small calculus be hidden in the tonsil and give rise, as it often does, to neuralgic pains in the depth of the aural meatus the causation of this symptom may easily be overlooked. Not infrequently I have seen the condition diagnosed as a "gouty" or "rheumatic" throat with consequent ineffective and possibly expensive treatment, especially when this involved a prolonged stay at a fashionable spa.

There should be no particular difficulty in establishing the presence of a calculus in the tonsil because the latter is generally redder than its fellow and pressure on its anterior surface causes pain. A blunt probe passed into the tonsillar fossa or into some of the upper lacunæ will rarely fail to detect the rough surface of the tonsillolith.

Small ones can easily be removed by a small hook or spud, the larger ones may have caused such a degree of tonsillar inflammation and sepsis that enucleation of the whole gland will be the best form of treatment.

## SURGERY IN ITS RELATIONSHIPS TO THE FUNCTIONS OF THE TONSILS

It is generally held that whatever else may be the functions of the lymphoid constituents of Waldeyer's ring, their protective role is the most important of them. But curiously enough the textbooks seem to have omitted one argument which Nature herself frequently proclaims, and her proclamation may often be read on the walls of the oropharynx—but do we always grasp the meaning of her message?

It must frequently have fallen to our lot to be consulted by young adults whose tonsils had been enucleated when they were young children. What do we sometimes find when they consult us later in life? A hypertrophied somewhat edematous band of congested mucous membrane corresponding to the so-called "lateral pharyngeal band." Or it may be several large patches of granular pharyngitis on the posterior wall. We may also be surprised to find that, in spite of our enucleation of "the tonsil complete in its capsule," there has appeared a considerable mass of lymphoid tissue in the lower halves of the tonsillar recesses. What do these appearances mean? To me they signify that Nature insists on having some lymphoid tissue in the oropharyngeal and nasopharyngeal regions and if it be too radically removed in a child, it may be replaced where it is required. That so-called "recurrent tonsil" may not be what our operation left behind, but lymphoid tissue pushed upward from the side of the lingual tonsil.

If such observations and their explanation be correct, what practical inferences are to be drawn from them? Is our tonsillar surgery sometimes too drastic? Are there any means by which we can foretell when such compensatory developments will occur? I ask these questions because I have seen and have had to operate on chronically inflamed lateral pharyngeal bands as large as an ordinary lead pencil. They had caused much pain when they became acutely inflamed.

Let me bring to your attention one other consideration and this of ethical bearing. When we meet with these compensatory adjustments in the possibly aggrieved patient of a colleague, let us remember that of "Faith, Hope and Charity the greatest of these is Charity."

## SURGERY IN ITS RELATION TO THE TONSILS AS PORTALS OR CARRIERS OF INFECTION

It is obvious that on this time limited occasion one can only touch on the general principles which this subject involves. We are all familiar with the acute tonsillitis which often heralds the onset of such acute specific fevers as scarlet fever, acute rheumatic fever, and, not infrequently, diphtheria.

We know that the tubercle bacillus, in more stealthy and less dramatic form may invade the tonsillar tissues, pass through them, and cause a tuberculous adenitis of the cervical glands, and do so without causing any macroscopical changes in the tonsil itself

We have also reason to believe that certain types of arthritis, myositis, neuritis, and other aural, ocular, cardiac, and distal manifestations of sepsis may be primarily of tonsillar origin

For the few moments at my disposal it is only possible to make some brief statements on the most important of these infections

1 *Diphtheria* It has been my experience to cure quickly some otherwise intractable diphtheria carriers by enucleation of the tonsils which on bacteriological examination revealed the Klebs Loeffler bacilli in the crypts One patient had been isolated for 6 weeks after convalescence, another for 9 weeks Both of them appeared to be in perfect health and were anxious to take up their ordinary work

2 *Tubercle* A vast amount of work and investigation has been carried out on the subject of tuberculous infection of the cervical glands by way of the tonsils

My personal and purely clinical experience supports the contention that true tuberculous infection of the tonsils is not common and occurs in not much more than 5 per cent of the cases It would appear that enlargement of the tonsils is primarily due to pyogenic organisms and that these bring about the cervical adenitis which later on becomes infected by the tubercle bacillus This would explain why enucleation of the tonsils is so often followed by the gradual disappearance of the glands in the neck, provided they have not already begun to break down and suppurate

If such a contention be correct it follows that the earlier septic tonsils are removed, the better will be the prognosis with regard to the cervical adenitis and tuberculous infection of the glands To those who are interested in the subject I would suggest reference to monographs by Howarth and Gloyne<sup>1</sup> and by Ritchie Paterson<sup>2</sup>

3 *Chronic arthritis* It will generally be conceded that, in the absence of definite bony changes around the joint articulations, the removal of septic tonsils will cure or give considerable relief in about 50 per cent of the cases In this matter I have seen some very gratifying results, but equally disappointing failures, and must confess that, so far, I know of no definite clinical signs on which to base a prognosis Suffice it to say, that enucleation of septic tonsils seems to promise a good result if the history of the patient shows that an attack of tonsillitis is followed by aggravation of the joint symptoms and also if, in the quiescent periods, the anterior faucial pillars are of a purple red color

This appearance generally indicates that the 'streptococcus viridans' is the offending organism

But we must not forget that disorders of metabolism might, if corrected, relieve a large percentage of the cases which tonsil enucleation has failed to alleviate If time permitted, this aspect of the subject might profitably be discussed

But one of our most important problems seems to lie in the attitude which we as surgeons should adopt in cases of acute rheumatic infection Let me give you only two examples of the many difficulties which so frequently confront us

1 A child suffered from a cardiac lesion following immediately upon an attack of acute tonsillitis After 3 months' convalescence, I enucleated the tonsils A fortnight later she was readmitted with some pericarditis, and eventually she left the hospital a cardiac invalid

2 A girl aged 13 years, with enlarged tonsils, had suffered from sore throats Then there supervened an attack of acute rheumatism with mitral disease from which she made a good recovery Three weeks later the tonsils were enucleated, 3 days after the operation the temperature rose, and a dangerous and nearly fatal carditis and pericarditis rapidly developed

Now arises the problem Were these patients directly inoculated by the micrococcus through the raw surfaces exposed by operation while their susceptibility to infection was still high?

<sup>1</sup> Laryngol & Otol 1924 A 8

<sup>2</sup> Laryngol & Otol 1929 Aug

I quote these two cases from the Lettsonian Lectures "On Rheumatic Heart Disease in Childhood" delivered by my friend and hospital colleague, Dr F J Poynton. As you may know he and Dr Paine in 1899 and in the earlier years of this century were the first to establish, by animal experimentation and clinical observation, the streptococcal origin of rheumatic infection.

The cases I have cited prompt at least two questions (1) When do the tonsils lose their protective function and become a source of danger? (2) How are we to determine when convalescence from an attack of acute rheumatism is so complete that we may safely remove diseased tonsils in order to prevent or minimize the chances of a further attack? I hope some of you will be able to answer these questions.

Poynton asks (*loc cit*) a question which we must often have asked ourselves viz 'A child has an attack of rheumatism with evidence of tonsillitis, there is apparent recovery, the tonsils seem healthy and the tonsillar glands are enlarged to a slight degree or not at all. Ought or ought not we to advise their removal as a precautionary measure? If we feel that we should do so, should we operate at the end of the acute illness or should we wait until the child has made a thorough convalescence?'

It would be very interesting to hear your experience as to the occurrence of first attacks of rheumatism in children who have already had their tonsils enucleated. If it be frequent, then we must be more careful in the selection of cases for surgical treatment.

#### MALIGNANT DISEASE OF THE TONSILS

Primary carcinoma and sarcoma are the two commonest forms of malignant disease of the tonsils, and I refer to these lesions only because on a few occasions patients have presented themselves with a mass of hard glands behind the angle of the jaw and no primary lesion could be seen in the throat or nasopharynx. But on enucleation of the tonsil and microscopic examination of the sections, the small and unsuspected primary growth was found.

An analogous but more obvious condition is sometimes seen in the tongue, viz a small primary growth and a large mass of glands or conversely, a large fungating ulcer with very small metastases in the cervical nodes.

With regard to the treatment of the primary growth in the tonsil, radiotherapy seems to have completely ousted cutting operations and diathermy. One need scarcely say that small doses of the screened element, or of its emanations, are inserted in and around the growing margin of the tumor and left for from 5 to 8 days. Infected glands in the neck are removed by a block dissection either before or after radiation of the tonsil lesion, and the affected triangles in the neck are given further exposures from time to time.

The increasing frequency of the good results of such treatment must surely be among the triumphs of modern medicine.

#### POSTOPERATIVE COMPLICATIONS OF TONSILLECTOMY

**Hæmorrhage.** An experience of 33 years seems to me to have proved that hæmorrhage is the most frequent accident following removal of the tonsils and the one most feared by the patient if he or she be an adult or by the parents in the case of their child. If one visualizes for a moment the anxiety which such a complication may cause the possible necessity for a second anæsthetic in order to secure one or more bleeding points the alarming degree of anæmia which may quickly result, and the prolonged convalescence to normal health we may well ask our selves the question "Do we always sufficiently prepare our patients for this operation and in carrying it out do we endeavor by proper surgical measures to minimize the risk of postoperative bleeding?"

To go into lengthy answers to these questions is impossible and I can only briefly state my own views and practice. For some 13 years I have enucleated all tonsils in private practice and in hospital by dissection. Previous to that period I used the guillotine method as introduced by Whillis Pybus and Sluder and by keeping a careful record of all cases from infancy to old age (my oldest patient, aged 72 years, suffered from 3 to 4

quinsies a year), found that my cases of bleeding which required active intervention were about 5 per cent. Since I employed dissection they have been reduced to 1 per cent.

I believe the reduction may be explained in two ways: (1) by the well known physiological fact that the torn or lacerated end of an artery contracts and retracts more readily than if it be cut or divided by a more or less sharp instrument, and (2) in every patient from the youngest to the oldest, I ligate the descending branch of the posterior palatine artery and if necessary the tonsillar branch of the facial in the lower region of the tonsil recess. Furthermore, no patient is allowed to leave the operating table until the tonsil beds are dry.

The time required for such operative details is rarely more than 10 to 12 minutes. Compared with the guillotine method, dissection takes longer, but stopping all bleeding demands less time so what "we lose on the swings we can make up on the roundabouts."

For years I have preached the advisability of ligating, but at first my voice was "as of one crying in the wilderness", today I am glad to say that this practice is becoming more universal, at any rate in England. To place a ligature securely round an actively bleeding vessel requires possibly from 5 to 6 seconds, and the operator leaves the home or hospital with his mind free from any anxiety. When surgeons write in the journals or tell me that they check operative hæmorrhage by pressure with gauze swabs, I would ask them two questions: (1) Why do you do for the tonsil recesses what you would not do in the case of a bleeding artery in any other accessible part of the body? (2) How do you know that there will not be some postoperative vomiting, crying or restlessness, and that the strain of these will not re-open the unsecured end of a small artery?

I know it requires considerable practice and some little dexterity to recognize and tie the chief arteries which supply the tonsils, but surely it is our bare duty as experts to attain some particular skill in our craft, otherwise wherein lies the *raison d'être* of our calling? Nevertheless, however careful we may be in the preparation of our patients and in the

technique we adopt, an occasional postoperative hæmorrhage will prove that we are but human and our methods fallible. About 12 months ago I enucleated the fibrous tonsils of a man who was subject to recurrent quinsies. The hæmorrhage was so excessive that I ligated 7 bleeding points and the tonsil beds were dry when he left the operating theater. Four hours later hæmorrhage recurred and, before I could get to him, he was pulseless at the wrist, exsanguinated, and begging in a whisper for "more air." Intravenous saline injections, stimulants, and the removal of clots from the tonsil recesses stopped the bleeding and he recovered. Fortunately such experiences are rare and they should continue to be so but only if we employ the first rule of surgery in checking arterial hæmorrhage, viz., to seek for the bleeding point and ligate it.

I know no other method by which we can discharge the responsibility of doing our best for the safety and sanctity of a life entrusted to our care.

#### PULMONARY COMPLICATIONS AFTER TONSIL OPERATIONS

Of pulmonary complications after tonsil operations, it has been my good fortune to have had practically no experience in my own practice nor have I seen such cases in consultation with my colleagues. Sir St. Clair Thomson makes a similar personal statement in the last edition of his book on *Diseases of the Nose and Throat*.

It is therefore impossible for me to discuss a complication from which we seem to be relatively immune in England.

From your literature on the subject I gather that you consider that severe pulmonary complications may arise from direct inhalation of septic material which is liberated at the time of operation on the tonsils, or from septic thrombosis of the veins in their "recesses" which lead to the formation of pulmonary emboli.

I do not know in which position you place your patients during enucleation, ours generally have the head extended by means of a sandbag under the shoulders, so that all blood and secretions pass into the nasopharynx and cannot get into the lower air passages. Again,

we never adopt the sitting or semiprone positions, no pillow is allowed in the bed until the patient has recovered the cough and swallowing reflexes. Finally, obvious dental sepsis is treated before the tonsils are operated on.

And now I have only to thank you for so patiently listening to me while I have tried to discharge the honorable task you invited me to undertake.

Like the song of Nanki Poo in "The Mikado," my contribution to your proceedings has been, I fear, "a thing of shreds and patches," little experiences and thumbnail sketches drawn from a pilgrimage of 33 years; but if any of them have interested you or stirred your imagination I shall indeed take away with me a most abundant and satisfactory reward.

# RADIOLOGY AS A COMPLETE OR PARTIAL SUBSTITUTE FOR SURGERY IN TREATMENT OF CANCER OF FEMALE PELVIC ORGANS<sup>1</sup>

JAMES HEYMAN, M.D. STOCKHOLM SWEDEN

FIVE years ago I had the honor to submit before this distinguished Society at its Congress in New York the results obtained at Radiumhemmet in Stockholm with the radium treatment of carcinoma of the uterine cervix.<sup>2</sup>

During the last 5 years our conception of the interrelationship between surgery and radiology in the treatment of cancer of the female pelvic organs has been clarified on many points. Our ability to decide in what type of case one or a combination of both methods should be used has been considerably enhanced. It is my intention in this paper to present to you the views which our experience at Radiumhemmet has led us to adopt in this regard.

## CARCINOMA OF THE CERVIX

The number of cases of cancer of the cervix radiologically treated and followed up for 5 years is sufficiently great to allow positive conclusions to be drawn from a statistical comparison between the results obtained by radiotherapy and those obtained by surgery. This, however, holds good only for a comparison of the figures for the so called absolute cure rate, i.e. the number of cured cases 5 years after the treatment expressed as a percentage of all cases presenting themselves.

In 1927 I made a careful computation of the results obtained by operative treatment<sup>3</sup> comprising all the statistics published in the literature of the world from which the absolute cure rate with the extended operations could be exactly deduced.

In Table I these results will be found compared with the results obtained at Radiumhemmet by radiological treatment.

It will be clear from Table I that the absolute cure rate for surgical treatment estimated

on 5,806 cases, of which about 54.6 per cent were operable, is 19.1 per cent.

The rate of cures obtained at Radiumhemmet in 1914-1923 in 700 cases treated radiologically, of which 25.5 per cent only were operable, is 20.6 per cent.

It should be noted that in the statistics of Radiumhemmet are included all cases of carcinoma of the cervix primarily treated by radiology, also those in which the patients have had only a single application for palliative purposes or on humanitarian grounds and those in which the patients have interrupted the treatment. In addition are included 53 patients, who partly on account of lack of accommodation could not be admitted.

Despite a considerably less promising, initial material our results are as good as, or even slightly better than, those obtained by surgery. The latest statistics, among others those of Menge in Heidelberg and of Ward in New York, show results similar to those of Radiumhemmet. There would seem to be no doubt, therefore, that by a properly carried out radiological treatment of cancer of the cervix one should be able to obtain at least as good results as by operation, so far as absolute cure is concerned.

The comparison of the absolute cure rates is the only reliable method of estimating the results. All other methods will involve a greater or less degree of ambiguity.

A comparison, for instance, of the results obtained in operable cases alone is less reliable

TABLE I—THE ABSOLUTE CURE RATE IN THE TREATMENT OF CARCINOMA OF THE CERVIX

	Surgical treatment Literature of the world	Radiological treatment Radiumhemmet 1914-1923
Cases examined	5,806	90
Cured	1,111	163
Absolute cures per cent	19.1	20.6
	Average operability per cent	Operable cases per cent
	54.6	25.5

<sup>1</sup> This paper covers the results of a study of the treatment of carcinoma of the cervix and carcinoma of the uterus and of both organs by the method of extended operations.

<sup>2</sup> Acta Radiologica 1927, vol. 10.

TABLE II — THE CURE RATE IN OPERABLE CASES OF CARCINOMA OF THE CERVIX

	Surgical treatment Literature of the world	Radiological treatment Radiumhemmet 1924 1925
Cases treated	3 629	188
Cured	1 303	76
Percentage cured	35.6	40.4

for several reasons of which the following are the most important

1 The number of so called operable cases in the radiological statistics is still relatively small

2 The conception of operability varies widely with each individual investigator During the visit of the American Gynecological Club to Radiumhemmet in 1926, I demonstrated our therapeutic technique in a case of cancer of the cervix which I held to be a border line case Reuben Peterson, Joseph Brettauer, and George Gray Ward, unaware of my classification of the case, examined the patient at my request Of these three gentlemen, one considered the case operable another thought it a border line case and the third felt inclined to look upon it as inoperable This episode illustrates how, even among experts, the idea of operability may vary

3 The statistics of operable cases, treated radiologically, include all cases which on clinical examination have been considered operable The corresponding group of the surgical statistics, on the other hand, excludes those cases which, it is true the surgeon considered operable before the operation, but which at operation he found to belong to the inoperable group Such cases undoubtedly occur not infrequently In Weibel's statistics<sup>1</sup> they amount to 10 per cent, and in a series of 33 cases operated upon and referred to us for after-treatment this was found to be the case in more than 12 per cent

The relatively small number of operable cases in radiological statistics, as well as the above mentioned possible irregularities in the initial material compels us to be careful in arriving at conclusions

In a comparison such as this (Table II) however, the superiority of radiological treatment in operable cases seems to be rather more pronounced than is the case in a comparison of the absolute cure rates

The results submitted by Ward Schmitz, and Regaud, among others, point in the same direction

In these comparisons no regard has been paid to factors in favor of radiological treatment, such as (1) a lower primary mortality (1 to 2 per cent as against an average of 15 per cent by operation), (2) a reduced morbidity, and (3) considerably less discomfort for the patient

On the strength of the evidence presented above it seems to me that in the future the radiological treatment is likely gradually to replace extensive operations as the method of choice in the treatment of cancer of the cervix

As a matter of fact, this has been the rule in Sweden since 1920 when Radiumhemmet presented its first 5 year statistics to the Swedish surgeons At the suggestion of Forsner and Essen Moller Swedish surgeons concluded to submit their operable cases to radiological treatment Since 1920 only a small number of operable cases have been operated upon in Sweden

It is obvious that a change from operative to radiological treatment is possible only when and where the necessary conditions for successful radiotherapy are available Where this is not the case, radiological treatment cannot attain results comparable to those of surgery, especially those obtained by the skillful masters of surgery in whose hands the results of extended operations are better than is indicated by the average figures submitted

Yet it seems to me that the growing generation of young surgeons, who have not had the time to acquire the dearly bought technical skill and judgment of their masters, is less likely to make use of extended operations As the availability of thorough radiological treatment increases the extended operation for cancer of the cervix will tend to become less and less frequent

It has been suggested that operation should be confined to the earliest cases, and that, in order to reduce the primary operative mortality—one should be content with the performance of a simple hysterectomy followed by postoperative radiological treatment In our opinion this form of combined treatment is not the most promising

Out of 24 early cases operated upon during the period from 1914 to 1924 and referred to us for radiological after treatment, 11, i e., 45.8 per cent, lived 5 years after the operation. This recovery figure is only slightly higher than that of Radiumhemmet for all the operable cases and yet the primary operation mortality has been entirely left out of consideration. The recovery figure is considerably lower than the result we obtained in a similar series of 43 early cases in which we had 62.8 per cent of cures. We have a series of 9 very early cases, 1926 and 1927, which were referred to us for treatment after operation. The fact that recurrences have appeared in one third of these within 2 years will seem to support our opinion.

Regarding other forms of combined radical operation and radiological treatment, our experience is very limited. We have tried pre-operative irradiation in only 6 cases (4 operable and 2 inoperable). Five of these patients died of cancer within 1 year of the operation, 1 patient only, a very early case, has been alive, free from recurrence, for more than 8 years.

In certain cases of cancer of the cervix in which radiological treatment has failed, operation must be tried as a last resort. This applies to cases of incomplete disappearance of the growth or of local recurrences after radiological treatment.

In the course of 15 years we have tried operation after radiological treatment in a total of 50 cases: 39 cases for local recurrence or incomplete disappearance of the growth, 3 cases for recurrence in the fundus, 2 cases for recurrence in the glands, 6 cases of pre-operative irradiation (mentioned above).

The operation could be radically performed in two thirds of the cases (30 out of 47: 3 supravaginal amputations not included), 17 cases proved to be inoperable, the operation was not made difficult by the preceding radiological treatment in any of the 47 cases, some difficulty in separating the bladder from the cervix was encountered in one fourth of the cases.

The primary operation mortality was 16.2 per cent (6 of 37: 3 supravaginal amputations, 10 exploratory laparotomies not included).

The recovery was uneventful in two thirds of the cases (21 of 31, 3 supravaginal amputa-

tions, 10 exploratory laparotomies, and 6 primary deaths not included).

The results show that of 32 cases operated upon more than 5 years ago, 8 are alive, i e., 25 per cent, or, if 2 supravaginal amputations are deducted, 23.3 per cent.

Carcinomatous glands were found in nearly 50 per cent of those cases in which no glands were palpable at examination, in one third of the 30 radical operations carcinomatous glands were removed, 6 cases radically operated upon with removal of carcinomatous glands have been under observation for 5 years or more after the operation, of these 2 are alive and free from recurrence: 1 case 15, the other 6, years after operation.

#### CARCINOMA OF THE BODY OF THE UTERUS

To estimate the prognosis in cases of cancer of the body treated operatively or radiologically is at present exceedingly difficult. I wish to mention only two of the most important reasons for this.

1. Cancer of the corpus as compared with cancer of the cervix is in most parts of the world a relatively uncommon condition. The material available to the surgeon or the radiologist must therefore be relatively limited and is really as a rule too small for statistical computations.

2. The microscopical diagnosis is in a good many of these cases exceedingly difficult for the pathologist. When in doubt many pathologists prefer to report cancer and most operators in such a case would probably prefer to remove the uterus, thus giving the patient the benefit of the doubt. If, moreover, the resected organ has not been very carefully examined, it may very well happen that one or another case may have been included in the statistics that on more careful scrutiny should perhaps have been left out. It may be that in the individual statistics it is only a question of 1 or 2 cases, nevertheless these are apt very considerably to influence the estimation of the final result in these small statistics which are mostly based on about 25, rarely on as many as 50, treated cases. Our experience at Radiumhemmet confirms this fact.

The microscopical diagnosis in a proportion of our cases was not made by our pathologist.



but we had to rely upon the statements of the referring physician. In some we did not even get a detailed pathological report. With the view of getting our cases of cancer of the body uniformly classified we have tried, for the last 12 months, to collect and revise all the figures. In this revision, we have found it necessary up to the present to exclude entirely 3 of our 31 cured cases, the absolute cure rate thereby being reduced from 43 to 39 per cent.

The relatively small percentage of operable cases in our statistics and the large percentage of similar cases in the surgical statistics make it impossible to use the absolute cure rate as a standard of comparison. We still maintain that operable cases of cancer of the body should be treated surgically and, as a consequence, have had mostly inoperable cases referred to us. In addition to these we also receive a number of so called technically operable cases, by which we understand cases in which operation is contra indicated because of technical difficulties or general conditions. Each of these groups represents one third of all cases.

The subjoined table will show a comparison between the operative results collected from the world's literature and the revised results of radiological treatment of operable cases alone at Radiumhemmet (technically operable cases included).

TABLE III—THE CURE RATE IN OPERABLE CASES OF CARCINOMA OF THE BODY

	Surgical treatment Literature of the world	Radiological treatment Radiumhemmet 1913 1923
Cases treated	323	52
Free from recurrence	190	28
Percentage cured	58.8	50

It would seem from this table that operation in operable cases of carcinoma of the body is to be preferred to radiological treatment. In regard to the small number of cases, however, the comparison cannot be considered valid as long as we do not know whether the rigid standards regarding the histological diagnosis used at Radiumhemmet have been applied to the surgical statistics.

A larger series of cases providing a more accurate description of the histological condition is essential both for operative and for radiological statistics. Until such material is

available, by stereotomy should be the method of choice in the treatment of uncomplicated operable cases of carcinoma of the body.

With radiological treatment, one should be able gradually to gain the necessary experience in the border line cases. Among these exists a relatively large group in which, on account of general conditions and above all on account of technical difficulties caused by adiposity an operation though not contra indicated is less advisable. In making the choice between operation and irradiation in these cases, I have in recent years tried to individualize the treatment, always bearing in mind the clinical aspect of the uterine cavity.

As radiological treatment in carcinoma of the body has in some places yielded worse results than in cases of carcinoma of the collum one has felt inclined to conclude that radiotherapy would be less efficacious in cases of adenocarcinomata. The correctness of this conclusion seems questionable. To me it seems just as likely that the cause is to be found in technical difficulties met with in the treatment of carcinoma of the body.

In a relatively large number of cases of cancer of the body of the uterus we have to deal with a dilated and irregular uterine cavity. Into this we must introduce a radium container small enough to pass through the dilated cervix. It is reasonable to assume that in many cases small or large areas of the growth may fail to come in close contact with the radium container. That this is so would seem to be borne out by our observation of cases operated upon after radiological treatment. For not infrequently one finds that the growth has completely disappeared in the lower part of the body where the cavity is narrow, while a small remnant of the growth will be found in the excavated area of the upper part because that has been farther away from the source of radiation.

We individualize the treatment in the border line cases in the following manner: in cases in which the uterine cavity is narrow and of regular contour, and in which, therefore, one could expect a more uniformly close contact between the radium container and the uterine wall, the patient is irradiated and kept under frequent observation. Nothing is done as long

as improvement proceeds. If after a period of temporary improvement new symptoms arise, i.e., hemorrhage, discharge, or increase in size of the uterus, hysterectomy is done.

On the other hand, if the uterine cavity is irregular and enlarged, I prefer to operate and irradiate afterward. If in such a case great technical difficulties in operation exist, I have first treated by irradiation and then performed the more easily executed supravaginal amputation. By the pre-operative radiation I think I have decreased the risk of leaving a vaginal stump.

On the strength of our results, however, we consider ourselves justified in applying the same procedure even in operable cases, provided the patient consents to be placed under careful observation. Should the radiological treatment not be successful—which as a rule becomes evident after from 3 to 4 months—operation should immediately be performed. There need be no fear of any technical difficulties in an abdominal operation because of the previous radiological treatment, nor does the postponed operation, so far as we have been able to judge, incur any greater risk of spread of the carcinoma.

Our experience with such a combined surgical and radiological treatment is as yet too small, and the time too short, to permit of any conclusions regarding the results. Of 8 cases operated upon after radiological treatment before 1924, 2 are alive, 1 of these has been well for the last 9 years, and the other for 6 years. 1 died of intercurrent disease and another died of cancer more than 5 years after the treatment. In the period from 1919 to 1927, we have operated upon 22 cases altogether. Of these 12 are alive and free from recurrence 1 to 8 years after operation.

Naturally the inoperable cases of cancer of the corpus ought to be submitted to radiological treatment. The results are, even in regard to the outlook for a 5 year cure, far from bad. In a series of 26 cases we have had the good fortune to have 7 cases, i.e., 26.9 per cent, remain free from recurrence for more than 5 years.

It seems to us that hysterectomy for cancer of the body of the uterus should be combined with radiological postoperative treatment. Of

the 22 cases of cancer of the body which have been sent to Radiumhemmet for postoperative radiological treatment after total hysterectomy or supravaginal amputation, more than 17 are alive after 5 to 14 years, corresponding to a permanent cure of 77.3 per cent. This figure is so much more favorable than the average result for operation alone (58.8 per cent, see Table III) that it seems definitely to favor postoperative irradiation.

#### CANCER OF THE VAGINA

The surgical treatment of this condition, even in those rare cases in which a radical operation is feasible, rarely yields permanent results.

At Radiumhemmet, radiological treatment has been tried during the period from 1914 to 1923 in 14 cases, most of them in an advanced stage. Of these 1 is alive 11 years and another 6 years after the treatment. A third patient died after having been well for 11 years, from ileus, confirmed by autopsy.

We must regard this result, 21.4 per cent of cures, as remarkably good. In our opinion operation should be entirely replaced by irradiation in cases of this type.

#### CANCER OF THE OVARIES

In the gynecological literature the 5 year cure by operation alone in radically operable cases of cancer of the ovaries is generally estimated to be about 30 per cent, somewhat higher for unilateral and considerably lower for bilateral tumors. Judging from our results, a permanent cure is more often obtained in radical operations when combined with postoperative irradiation. At Radiumhemmet we have had in a series of 32 cases, 65.6 per cent of 5-year cures. In 27 unilateral tumors the percentage was 76. Of 5 patients with bilateral tumors 2 are alive after more than 5 years.

In cases in which it has been impossible to perform a radical operation because of metastases but in which it was possible to remove the ovarian tumors remarkable results have often been obtained by radiological treatment. In a series of 30 such cases treated at Radiumhemmet, there are quite a number of patients who for several years have been kept free from symptoms and able to work. Among those are

7 who were under observation for 5 years or more. The cases differ too much clinically, the patho anatomical classification is too incomplete, and the material of the different groups is too small to allow of a statistical estimation of the results.

In completely inoperable cases the radiological treatment is, it is true, of an exacting nature, but can, if correctly carried out bring with it a considerable reduction of the tumor and a marked temporary improvement in the general health of the patient. In some cases the patient can be kept free from discomfort for 1 or 2 years. Only twice have we seen 5-year cures, in neither of those was the diagnosis microscopically verified. One of the patients lived for 9 years and died of recurrences, the other one is alive and has been free from subjective symptoms for the last 7 years.

With the view to improve, if possible the outlook for a permanent cure, I have in recent years performed a relaparotomy in those cases in which the tumors have shrunk and become mobile under radiological treatment. In 3 out of 5 such cases, the operation was easily performed. Of those 1 is alive and has been free from recurrence for the last 2 years and another for the last 9 months.

Thus, in our opinion, no permanent results can be obtained in the treatment of cancer of the ovaries without resort to surgical intervention. On the other hand, it is undoubtedly true that an intimate co ordination of radiological and surgical treatment can improve the results considerably. The removal of the ovarian tumors should always be tried, if the risk involved is not too great. If the risk is too great, then it is better to trust to radiological treatment. In the surgical treatment we would advise the operator not to remove the uterus, but to retain it so that it may be used as a means of applying the radium in after treatment, thus enabling the radium container to be centrally placed in relation to the original site of pathological change. After operation radiological treatment should be instituted without delay.

#### SUMMARY

Briefly summarized our opinion regarding the interrelationship between surgical and ra-

diological treatment in cancer of the female pelvic organs is as follows.

In cases of cancer of the cervix radiological treatment is the method of choice. Operation should be resorted to only if radiological treatment has failed.

Operable cases of carcinoma of the body should be operated upon and submitted to postoperative irradiation.

Regarding the relatively large group of border line cases in which surgical interference on account of general conditions and technical difficulties, is less advisable, one must in making the choice between surgical and radiological treatment, carefully consider the size and shape of the uterine cavity. Surgical treatment is to be preferred in cases with a large and irregular uterine cavity, whereas radiological treatment is more likely to be successful if the cavity is narrow and of regular shape.

In cases of cancer of the vagina surgery ought to be entirely replaced by radiology.

In cancer of the ovaries an intimate co-operation between surgical and radiological treatment is required. Surgical treatment aiming at the removal of the ovarian tumors must be tried first. In patients who have had the radical operation as well as in those who have not had the radical operation, operation must be followed by irradiation. In a number of these cases radiological treatment will bring about a considerable improvement and in some it may pave the way for a subsequent successful operation.

In order to be able to substitute entirely or in part radiological for surgical treatment to the extent advocated in this paper, it is necessary to have at one's disposal a radiotherapeutic institution which, first of all, should be equipped with all technical appliances and instruments for thorough comprehensive roentgen therapy and radium therapy. Second there should be in addition a well organized department of social service for following up the patients and finally, the clinic must be under the direction of well trained and experienced radiologists with an adequate staff.

#### DISCUSSION

DR. HENRY SCHMITZ, Chicago: Perusal of the statistics given by our distinguished visitor Professor Heyman and others contained in medical liter-

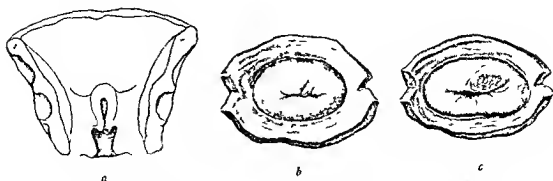


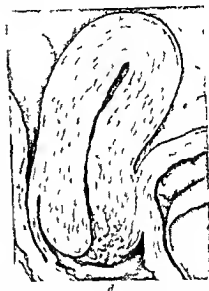
Fig. 1 The findings on palpation and inspection of a Group 1 localized carcinoma of the vaginal portion of the uterine cervix. a Section showing the absolute localization of the carcinoma within the limits of the cervix uteri. b The beginning cancer nodule. c The ulceration of a cancer nodule. d Sagittal section showing the invasive tendency of the clearly localized cancer nodule and ulcer.

ature may well explain the continued interest of the medical profession in the controversy as to whether surgery or radiotherapy is the treatment of choice in carcinoma of the uterine cervix. Whoever has had the opportunity to visit the Radiumhemmet at Stockholm to study its organization and purposes and to see the 5 year good end results obtained in the treatment of carcinoma in the various regions of the body will admit that this success is due to the unbiased attitude of the Swedish medical profession and to the technique of radiation treatment and the follow up system developed under the leadership of Forssell the director since 1910.

In the United States the question whether to operate upon or to treat with radiation carcinomata of the cervix uteri is still under discussion. Cases which should come within the scope of surgery and those which fall within the scope of radiotherapy can be definitely selected. It is obvious that those patients should be operated upon in whom the growth can be totally eradicated and that those patients should be subjected to radiation treatment in whom the entire cancer cell bearing area can be exposed to a lethal radiation dose. Relative operability or relative radiability should not enter the surgeon's judgment. To facilitate the selection of cases for these therapeutic measures a grouping has been formulated in our clinic which is based on the clinical findings of the extent of the tumor by palpation and inspection as follows:

1. Beginning nodule or ulcer not larger than 1 centimeter in diameter with normal mobility of uterus and adnexa.

2. A tumor or ulcer involving one half or all of the cervix in either the transverse or the longitudinal diameter and a dough like consistency of the parametrial tissue. The uterus then assumes a decreased mobility due to loss of normal elasticity of the adjacent connective tissue.



3. (a) Tumor or crater of the cervix with rigidity of adjacent tissues. (b) involvement of the parametria, the regional lymph nodes or both. The mass as a whole has impeded mobility.

4. (a) Involvement of the parametria, the regional lymph nodes or both, with fixation. (b) involvement of bladder, rectum or vagina, and (c) distant metastases (Figs. 1 to 12).

The indications for the various methods of treatment are as follows: in the clearly localized carcinomata of Group 1 either panhysterectomy or radium may be employed in the doubtfully localized carcinomata of Group 2 radium is used, the clearly in operable or advanced carcinomata of Group 3 indicate a combination of radium and X ray treatment, and the terminal or fixed carcinomata of Group 4 require palliative treatment. A fixed carcinoma in any part of the body as a rule gives an absolutely bad prognosis and should not be subjected to needless and expensive treatment.

Operability depends upon the following factors: (1) normal mobility, (2) patency of the cervical canal, (3) age of patient, (4) absence of pathogenic

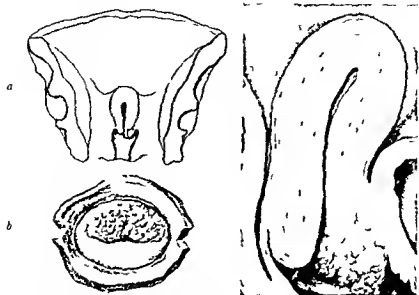


Fig. 2. The findings on palpation and inspection of a Group 2 doubtfully localized carcinoma. a. Invasion of at least one half of the cervix. b. The visual findings. c. Sagittal section showing the invasion of the paracervical connective tissue.

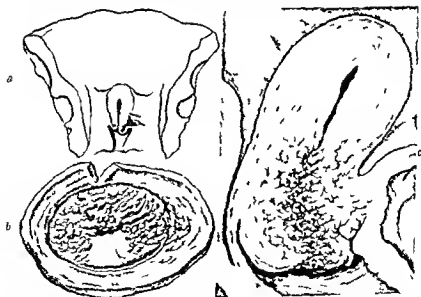


Fig. 3. The findings on palpation and inspection of a Group 3 advanced carcinoma. a. Transverse section showing extension into parametrium and progressive invasion of entire cervix. b. The visual findings. c. The extension toward adjacent organs seen in a sagittal section.

bacteria in the genital canal and (5) good surgical risk. The absence of any one of these 5 conditions contra indicates surgery. Mobility is normal if the uterus can be pulled down without resistance to the

introitus vaginae with a tenaculum forceps applied to the cervix. Patency of the cervical canal is tested by the insertion of a uterine sound. Stenosis always an evidence of pyometra. Afebrility should be

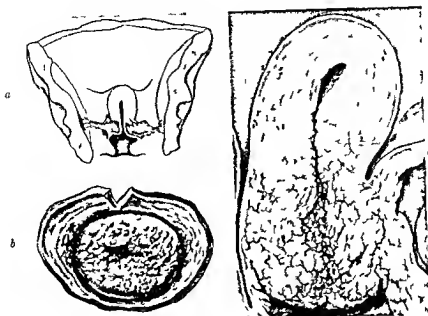


Fig 4. The Group 4 terminal carcinoma with fixation. a Transverse schematic section showing the frozen pelvis. b The visual findings. c The extensive involvement of uterus seen in a sagittal section.

determined to rule out such infectious processes as parametritis, adnexitis, perimetritis, and non pelvic infections. Differential leucocyte counts will aid in the finding of active infectious processes. The pathogenicity of the cervical canal flora may be decided by the Kuge and Phillips test. Ten centimeters of defibrinated blood taken from the patient's arm vein and placed in a Petri dish are inoculated with the cervical discharge. If cultures grow within 4 hours one may assume that pathogenic bacteria are present. The surgical risk depends upon many factors such as grave metabolic disturbances, renal, cardiac, hepatic and pulmonary diseases and severe degrees of anemia. Some of the conditions may be overcome by proper medical management and operation may then be performed.

The contra indications to the use of radiation are:

1. General emaciation and cachexia. When these are present, radiations may cause a rapid increase of both and early death.

2. Anemia with a red cell count below 3,000,000 and a hemoglobin index below 50 per cent. Radiations have a tendency to produce an oligo-erythrocythemia and leucopenia and hence may increase the anemia to a danger point.

3. Impaired nitrogen metabolism. Radiations as a rule produce a rapid increase in the blood nitrogen which may assume dangerous proportions in the presence of an impaired nitrogen metabolism.

4. Complications in the urinary and rectal tract. Bullous edema and carcinomatous involvement of the bladder or the rectal mucous membrane, fistulae and urinary retention due to obstruction or cancer

invasion of ureter and kidney, either with or without infection, are made worse by radiation irritation and fibrosis.

5. The frozen fixed pelvis is usually an indication of an existing generalized carcinomatosis.

6. The presence of inflammatory lesions or foul sloughing condition of growth or pyometra. Experience has shown that local manipulations may aggravate such infectious conditions.

7. Amenorrhea and pregnancy. Radiations are detrimental to the normal development of the fetus. Some of these conditions may be overcome by proper medical treatment when radiations may be used.

The rules given have been carefully observed in our clinic. Variations in the subjective interpretation of operability and inoperability have thereby been reduced to a negligible number. Since 1917 operations for carcinoma of the cervix uteri have been discarded and all cases except those in Group 4 have been treated with radium and X rays. The low percentage of absolute operability, the high frequency of contra indications to surgical treatment and the good end results of radiation treatment were the reasons for this decision. Should a carcinoma of the

TABLE I—THE FIVE YEAR GOOD END RESULTS OF RADIATION TREATMENT

Clinical Group	1	2	3	4	Total
Total number	23	48	161	100	332
Number of 5 year good end results	18	20	20	0	58
Percentage of 5 year good end results	78	41	68	0	51

cervix uteri of Group 1 or 2 prove refractory to radiation therapy, then operation may be considered to offer the patient a possible chance of relief.

The 5 year good end results prove that radiation treatment of carcinoma of the uterine cervix gives a high percentage of absolute cures without the high morbidity and primary mortality of surgery.

They also indicate that the control of cancer of the uterine cervix depends on an early admission of the patients, an immediate diagnosis and prompt and adequate treatment. The smaller the growths are the higher should be the percentage of 5 year good end results.

The clinical grouping of carcinoma based on the demonstrable extent of the tumor enables one to choose the indicated treatment and to compare the absolute curability percentage obtainable with either surgery or radiation treatment. It also aids in the prognosis as cancers of Group 4 characterized by fixation almost always offer a poor prognosis while the chance of recovery in Group 3 carcinoma is about 1 in 3, in Group 2 carcinoma about 4 in 10, and in Group 1 carcinoma about 8 in 10.

DR ARTHUR H. CURTIS, Chicago, Doctor Heyman's contribution is a refutation of the old adage to the effect that statistics are unreliable. Nationwide earnest co-operation of the most eminent men in all Scandinavia, laboring with one object in view, working not merely with the sanction of the government but assisted by it in every possible way, has resulted in this most valuable paper. Permit me sir to express to you our deepest admiration and respect for your work.

Lack of time necessitates a limitation of my remarks to a brief consideration of the treatment of carcinoma of the cervix.

Early years of disappointment in my attempts to cure cancer by operation and a vivid impression that the surgical results of others were not so good



Fig. 2. Surgical diathermy. A. Surface view of raw beef cooked by diathermy electrode. B. Sectional view revealing depth to which tissue is cooked. The depth of destruction of the tissue may be varied at will according to the strength of current and time of application.

as statistics indicated, impelled me to turn to the exclusive use of radium in nearly all cases of cancer of the cervix immediately upon introduction of radium therapy into this country. My late associate, Dr. Watkins, continued to operate upon favorable cases until approximately 8 years ago, at which time we made a survey of our combined experience. This demonstrated that radium treatment has been definitely superior to operation.

With the passage of time I have been increasingly impressed with the value of radium and with added experience in the technique of radium therapy I have noted a continuously greater percentage of clinical cures.

The technique of radium treatment is of vital importance. Simple introduction of radium capsules into the uterine canal fails to protect adequately against advancement of the cancer in the most critical regions, the adjacent cellular tissues. For approximately 10 years I have thrust radium needles deeply into the tissues in a palisade encircling the

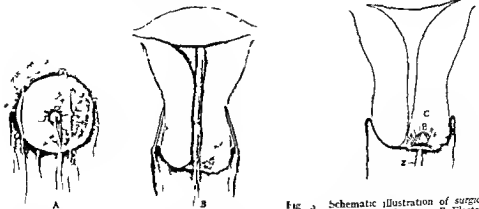


Fig. 3. Carcinoma of cervix, radium therapy. A. Cervical view showing radium needles thrust into the tissues in a palisade encircling the cervix. B. Sectional view. The needles should be slanted slightly toward the uterus.

Fig. 3. Schematic illustration of surgical diathermy treatment of carcinoma of cervix. E. Electrode. A depth to which tissue is visibly cooled. B. Extent of tissue destruction. C. Radius of heat destruction of cancer cells. Accumulated evidence indicates that this may equal or exceed the usual range of radium activity.

diseased cervix at the same time inserting a chain tandem of radium capsules into the uterine canal (Fig. 1). The needles which are plunged into the bases of the broad ligaments should be slanted slightly toward the uterus, otherwise there is a possibility of ureteral injury.

Lesser surgical procedures may be employed with advantage in a considerable percentage of patients at the time of radium application. Upward displacement of the bladder permits enormous increase in the dosage of radium to the anterior cervix and anterior vaginal wall in patients whose tumors tend to extend in this direction. The same is true of the posterior vaginal wall in those cases in which the progress of the growth is toward the rectum. In years past our tendency has been to radiate lightly those extensions in the vicinity of the bladder and of the rectum. Now we find that these viscera when not invaded may be protected by simple dissection and retraction away from the region which we desire to radiate.

*Surgical diathermy.* The surgical world seems to have forgotten the excellent results obtained by Byrne with the galvanocautery; overzealous employment of the Percy method of cauterization has apparently resulted in unjustifiable antipathy to heat destruction.

Since 1922 I have employed surgical diathermy as an adjunct to radium in the treatment of cervical carcinoma (Fig. 2). This form of heat destruction possesses all of the advantages of the actual cautery

and is free from many of its disadvantages. No open wound is created; the destroyed tissues separate by cleavage in about 10 days, leaving a smooth surface beneath. Destruction extends to approximately twice the depth to which the tissues appear cooked upon incision (Fig. 3). Accumulated evidence indicates that the cancer cells are destroyed far beyond this, often definitely beyond the usual range of radium activity.

Diathermy is most useful in the treatment of cauliflower cancer and necrotic cancer which has extensively destroyed the endocervix. Heat penetration of this character sometimes achieves remarkable results in conjunction with radium—sometimes without radium—it has added very materially to the percentage of our clinical cures.

#### SUMMARY

I wish to stress the importance of radium treatment beyond the outermost demonstrable extension of the growth.

I would emphasize the helpfulness of mobilization of the bladder and of the rectum in selected cases, in order that we may radiate malignancy of the cervix with the utmost efficiency, without danger of visceral injury.

Finally I am impelled to urge that we all make use of surgical diathermy; it is a most valuable adjunct to radium in the treatment of cancer of the cervix.



SURGICAL TREATMENT OF ACUTE INTESTINAL OBSTRUCTION<sup>1</sup>

WILLIAM B. HOLDEN, M.D. F.A.C.S. PORTLAND OREGON  
Department of Surgery Medical School University of Oregon

EVERY recovery from acute mechanical intestinal obstruction is due to modern surgery. Without surgery all would die. Surgeons save from 40 to 70 of each 100 cases of obstruction. We should save at least 90. This ideal is attainable. Its realization does not demand a larger conception of the mysteries of the death producing factors or newer methods of treatment. An intelligent application of our present knowledge of the pathology, symptomatology and operative management is all that is necessary to save 90 per cent of obstructed cases. No disparagement is intended to the many faithful pain-taking workers in the experimental field, who are endeavoring to solve the problems of the causes of obstructive deaths. When their work is finally completed, we possibly may be able to realize 98 or 99 per cent recoveries. Up to the present time, the experimental laboratory has produced little that has been useful clinically in lowering obstructive mortality. The administration of chlorides as brought out by Haden, Orr and others, is of definite value.

We have nothing new or startling to present. We shall simply call attention to well known facts, and emphasize some that we believe are important in improving surgical results in mechanical obstruction of the bowel. There is no field in abdominal surgery that challenges our attention more than this.

Refinements in surgery of the appendix, the kidney, the gall bladder, the stomach, and the pelvic organs may save 4 or 5 per cent more lives than now, whereas in acute obstruction an improvement of 20 to 50 per cent in our results is possible.

The incidence of intestinal obstruction will increase. Hundreds of thousands of laparotomies are being done every year. Each is potentially a case for ileus. Of our 177 operations for obstruction, 76 (43 per cent) were caused by previous abdominal operations done from a few days to 25 years before.

All clinicians agree that the operation must be done early. The results depend more on

when than by whom and how. An early operation by a novice in surgery is safer than a late operation by a master. Unlike cancer, the very hour of onset in obstruction is announced. Its progress is proclaimed by severe colic like pains repeated every few minutes. Woe unto the patient and discredit to the physician when these proclamations of pain are silenced by the hypodermic of morphine. Morphine is responsible for fully one half the operative deaths. It delays operation many hours and obscures otherwise obvious signs. It never does good but always harm. Abdominal pain, when sufficiently severe to require the hypodermic of morphine, generally demands that the sufferer be hospitalized at once and that means be taken to determine the cause of the pain. We have had two patients that were given repeated hypodermics of morphine for gall stone colic, but operation revealed in each a late case of obstruction. Both died not from the laparotomy, but from the hypodermic. These should be classified as hypodermic deaths and not operative deaths.

The official death certificate in the state of Oregon has these questions: "Did an operation precede death? For relief of that condition? Date of." To place the responsibility properly, the certificate should ask in addition: "Was morphine administered to this patient? If so how much, when and by whom?"

The vast majority of physicians, as well as surgeons recognizes the dangers of morphine. Every surgeon frequently encounters its deadliness. By repeated warnings, surgeons can educate the general practitioner to withhold morphine in abdominal pain. Such efforts produce results.

In one year recently we had only 3 deaths in 24 referred cases of obstruction. This is less than one half the average mortality in our referred cases. The responsibility of late operations is occasionally on the patient rarely on the surgeon but generally on the physician first called. Of our 34 deaths 20 can be attributed to the delay caused by morphine.

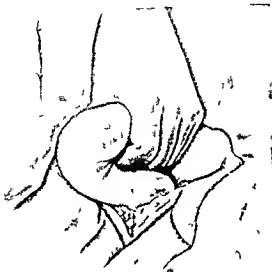


Fig 1 Intestines covered with hot gauze napkins

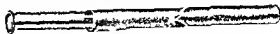


Fig 2 Test tube with rubber tube about 2 feet long

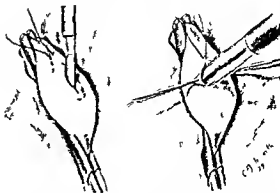


Fig 3 Opening bowel and inserting flanged end of test tube

administered by the first physician. In only 3 did the patient seek medical aid late. In 2 I was responsible for the fatal delay. Of the 9 remaining 7 were cases of cancer of the large bowel. The sudden, severe pain urges the patient to send at once for a physician. The sufferer seems intuitively to realize that relief cannot be expected from spinal manipulations or meaningless incantations.

A fairly accurate provisional diagnosis can be made at the bedside. No special apparatus or complicated maneuvers are necessary. A clinical thermometer and an enema can be the only indispensables. The five cardinal symptoms and signs are (1) pain (2) vomiting (3) blocked bowel (4) visible peristalsis, and (5) no fever.

1. The pain is abdominal, sudden, severe, cramp-like and colic like. Sleep is disturbed or impossible. The patient knows the very hour when "gas pains," as he frequently calls them, began. The pain is not referred to the bladder or under the right scapula. It is always present. Morphine erases this symptom from the picture.

2. Vomiting is generally seen. At first it is reflex; later it is constant from overflow of the stomach. Fecal vomiting indicates that the case has been mismanaged and further treatment will be unavailing. Obviously, the higher the obstruction the earlier constant vomiting

will appear. In low obstruction of the large bowel, vomiting may not be present. Morphine destroys the significance of this symptom.

3. Blocked bowel is frequently overlooked because the bowel will move once or twice after the obstruction has occurred. The bowel empties below the obstruction. After this, there is absolute constipation. Neither gas or fecal contents are passed. Repeated enemas should be given. Cathartics must never be administered, they do no good, but only harm. Not infrequently do we see patients who believe that they have bowel obstruction, because the bowels do not move and enemas are unproductive. This is not a mechanical block, for they have no pain or vomiting.

4. Visible peristalsis is frequently, though not always, seen. Its importance is underestimated. We regard it as very valuable. In conjunction with the other four cardinal symptoms it makes the diagnosis certain. Peristalsis cannot be seen if the patient has morphine. The fat abdominal wall obscures this sign. If the abdominal muscles are rigid, as occasionally happens, it is quite useless to look for visible peristalsis. Contrary to the statements of some, it is an early sign. We have seen it 5 or 6 hours after beginning of the ileus. It is a sign that is most valuable in determining the presence of obstruction in drainage appendix

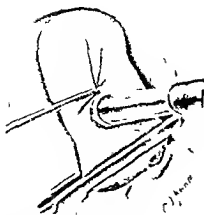


Fig 4 Hemostat on pursestring suture Intestinal clamp on distal side of enterostomy



Fig 5 Note that the tube is held nearly horizontal

cases which develop mechanical block while still in the hospital. We have had 12 such cases—10 of our own and 2 referred. One patient (a referred case) died. Eleven recovered. All showed visible peristalsis, and it was the determining factor in deciding the diagnosis in each instance. Let us consider a drainage appendix case in which the first few stormy postoperative days have passed. The bowels have been moving, and the temperature, pulse, respiration, and general condition are satisfactory. Suddenly, the patient complains of colic accompanied by vomiting, but no fever. After the first bowel movement, enemas return clear. Within a few hours, if sought for, visible peristalsis can be demonstrated. Even in the presence of a drainage wound, this sign promotes absolute confidence in the necessity of re-opening the abdomen.

In looking for visible peristalsis, the entire abdomen should be exposed. The patient must be in a good light. We frequently spend an hour or more inspecting the abdomen from directly above lengthwise, and crosswise. We may repeat this inspection after a few hours. A hasty glance at the abdomen is insufficient. An ampule of pituitrin hypodermically will at times magnify peristaltic waves until they can be seen plainly. Visible peristalsis does not always indicate obstruction. Babies may show this sign from a number of conditions. Hirschsprung's disease shows marked peristal-

tic waves. Elderly women with thin, flabby abdominal walls, show peristalsis but they have no pain, vomiting or a blocked bowel. Visible peristalsis is pathognomonic of mechanical obstruction only when accompanied by the other four cardinal signs.

5. Early, uncomplicated obstruction has no fever. Many physicians believe that there is increase of temperature in obstruction. The absence of fever in one referred case led the attending physician to decide erroneously against obstruction. Another time by calling attention to a temperature of 103 degrees we persuaded the attending surgeon to postpone operation for ileus. The eruption of small pox 3 days later made the postponement permanent.

The following may be regarded as occasional or minor signs: (a) relaxed abdominal wall, (b) tumor, (c) bloody mucus from anus, (d) distended abdomen, and (e) leucocytosis.

Relaxed abdominal muscles are very often seen. The muscles are flaccid. Placing the hand on the abdomen gives one the sensation of palpating a rubber water bag filled with water and no air. This flaccid condition of the abdominal muscles renders possible the phenomenon of visible peristalsis. If there is a considerable mass of strangulated bowel, the abdomen will be rigid. In intussusception and cancer of the large bowel, a tumor may be felt. Bloody mucus from the bowel is present in intussusception and at times in cancer.

Textbooks stress distention of the abdomen. Marked distention is a late sign, and we should not wait for it. Early the abdomen will be neither scaphoid or distended to any degree. We must make our diagnosis before distention.

The leucocyte count is not important. It will vary from mild to high. It is of little value in making a diagnosis.

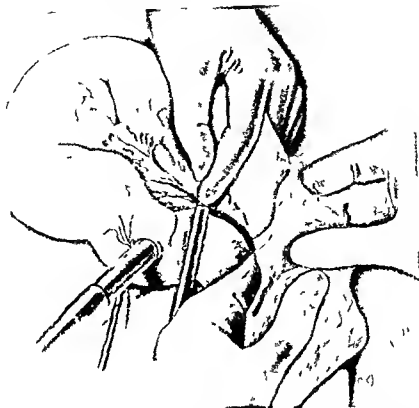


Fig 6 Assistant is pulling the intestine through the fingers of the operator

The X ray is extolled by some. Its use should not cause any delay. Only flat plates are permissible. Barium may be troublesome if there is obstruction. We have made very little use of the X ray. The provisional diagnosis by the general practitioner often is made where there is no X ray. It seems preferable to emphasize the simple, common, clinical signs and symptoms rather than suggest means of investigation that often are unavailable. We must simplify rather than complicate the early diagnosis of obstruction. The X ray is not essential to an early diagnosis. There is no objection to X ray if its use does not delay operation.

No effort is made to determine the site or cause of the obstruction. 'Is there an obstruction?' Not 'where' or 'why?' is the question to be promptly answered. The location and cause of obstruction may be harmless speculations. Determination of the presence of obstruction, somewhere, from some cause is

the great essential. On opening the abdomen, we can very quickly discover the situation and nature of the obstruction.

Operation must be performed early, i.e., from 12 to 24 hours after the onset of the attack. General anesthesia (nitrous oxide and ether) is the routine. In strangulated external hernias local anesthesia is most often used. The incision should be ample. We use the long mid line from pubis to a few inches above the navel (Fig 1, a). A short incision prolongs the operation and is incompatible with accurate work.

Excepting in strangulated external hernias, we employ evisceration in most cases. As soon as the intestines are removed, they are covered with large, warm salt gauze napkins (Fig 1). These are kept the proper temperature by the addition of more warm compresses. The temperature of the operating room should be at least 80 degrees F. If the chilling of the viscera and traction on the mesentery are

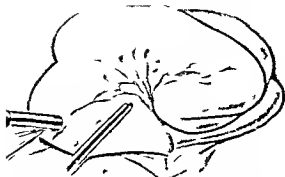


Fig 7 Intestine empty and flattened after stripping



Fig 8 Preparing to remove the test tube. Note that the flanged end is held high. Completing the closure of the enterostomy wound.

avoided, shock seldom will be seen. By evisceration, the exact pathology is quickly located and promptly corrected.

We have on several occasions resected the sigmoid when it was the seat of a volvulus and its circulation was questionable. Non strangulated obstructed, adherent coils may be short circuited by an entero enterostomy. We have done this only once, but regret that it was not used in 2 other cases.

Resection of gangrenous bowel is always hazardous and it is generally preferable to leave both proximal and distal ends of the bowel protruding through the abdominal wall. Anastomosis can be done later. Obstructing cancer of the large bowel also demands a two stage operation. Intussusceptions are best reduced by the pushing back of, rather than by traction on the invaginated bowel.

When the obstruction is relieved, the work is only partly done. There is a difference of opinion among experimental workers in regard to the toxicity of the imprisoned contents of the bowel above the obstruction. We believe that these contents are toxic. For 12 years, we have emptied the bowel above the obstruction.

An ordinary glass test tube  $3\frac{1}{4}$  inch in diameter, with a good flange at its upper end is selected. The closed end is cut off and fitted with a piece of rubber tubing not over 2 feet long (Fig 2). Near the obstructed point preferably just below it, a strong pursestring Lembert linen suture is placed longitudinally in the bowel. This small loop of bowel is caught lightly in an intestinal clamp. The intestine is opened within the pursestring linen

suture (Fig 3). The flanged end of the test tube is inserted into the lumen of the bowel and the pursestring is drawn taut with only the first loop of the knot and clamped with a hemostat close to the tube. The intestinal clamp is removed and placed just distal to the test tube (Fig 4). The distal end of the rubber tube is held at one side of the patient by a nurse (Fig 5). The operator's hands are now generously anointed with sterile vaseline. Beginning as near the duodenum as possible, the intestines are rapidly but gently pulled through the vaselined fingers by an assistant (Fig 6). This strips the contents of the bowel through the test tube and rubber tube into a basin held by the nurse (Fig 7). This maneuver may be repeated. Several pints of foul bowel contents may be secured. The intestinal clamp is then returned to the small loop of bowel holding the test tube (Fig 8). The hemostat is released, the pursestring loosened enough to allow the flanged end of the test tube to slip out of the bowel and the pursestring immediately tightened. This closes the opening in the bowel without soiling the peritoneum. A Lembert suture completes the closure of the intestinal wound. As the test tube is withdrawn its flanged end is held higher than the rubber tubing.

This entire procedure requires only 5 or 6 minutes. This loss of time is fully compensated for by the ease with which the abdominal wound may be closed and the time saved in that procedure. We recommend the test tube because of its simplicity and availability. The glass tube allows us to see whether the apparatus is working. Dr Sweet, of Phoenix,

has devised a metal tube with a sliding shoulder and set screw to take the place of the test tube. It is a good instrument. The rubber tube should be short and held nearly horizontal by the nurse, otherwise siphonage will draw the wall of the bowel into the tube. Three times we have been troubled by having the tube clogged with masses of corn or berry seeds. If the rubber tube is cut shorter these masses may be removed by a long gall stone scoop.

For more than 12 years we have used this procedure in practically all of our cases of obstruction, except external hernias. A few times in exceptionally early, simple cases, we have omitted it, but each time the stormy convalescence caused us regrets. Before we employed this means, our obstruction cases ran a very stormy course in which vomiting was annoying and gastric lavage was necessary every few hours for 2 or 3 days. Patients with obstruction, once they are relieved of the imprisoned bowel contents, run a smooth convalescence. Lavage is rarely necessary and postoperative vomiting is no more frequent than after an appendectomy.

The operation should be done with as little loss of time as is consistent with careful work. To allow from 30 to 40 minutes is ample. The abdomen is closed without drainage.

Proctoclysis, with normal saline, is routine. Hypertonic salt solution, subcutaneously, has been employed the past few years. For the first 24 hours sufficient morphine is given to make the patient comfortable. Cathartics are rarely administered and never before the fourth or fifth day.

Our impressions are based on the cases shown in Table I.

Of our 34 fatal cases 2 died after leaving the hospital. One had gangrene of the lung following postoperative pneumonia. He was an old man with strangulated hernia, which required resection. Autopsy showed a perfect abdominal condition but gangrene of the lung.

Another man died of lung abscess several weeks after leaving the hospital. This patient had some infection in the abdominal wound—a right rectus incision. It is presumed that he had a septic embolus from the deep epigastric vein. Inasmuch as both of these patients died

TABLE I—RESULTS

	Cases	Died	Mortality per cent
Cancer (large bowel)	22	7	32
Hernia (strangulated)	39	6	16
Postoperative adhesions (old)	64	14	22
Postoperative adhesions (new occurring before leaving hospital)	13	1	8
Intussusception	15	2	13
Volvulus	13	2	16
Miscellaneous	11	2	18
	177	34	19½
Referred cases	110	31	26
Not referred cases	58	3	5¼

of complications, directly associated with their surgical relief for obstruction, we include them in our deaths, even though they died after leaving the hospital.

Of our 177 cases 58 were first seen by myself or associates, with 3 deaths (5¼ per cent). No pre-operative morphine was given in any case. One of these was 48 hours old when we first saw the patient. The other had a 24 hour delay for which I was responsible. There were 31 deaths (26 per cent) in the 110 referred cases.

Both classes of cases had the same operator and the same operation. One had five times the death rate of the other. Why? Delay! Why the delay? Generally—*morphine!*

#### CONCLUSIONS

Our conclusions may be summed up as follows:

1 Surgical mortality of occult intestinal obstruction should, and *can*, be 10 per cent or less.

2 Early operation, i.e., within 12 or 24 hours is essential.

3 The medical profession must avoid the pre-operative use of morphine and cathartics for acute abdominal pain.

4 The imprisoned bowel contents above the obstruction should be removed.

5 Hypertonic salt administered subcutaneously and normal salt solution given by rectum are necessary to replenish the lost chlorides.

#### DISCUSSION

DR JOHN A. WOLFER Chicago. I wish to congratulate the essayist for his courage in standing firmly on the ground of common sense in the diagnosis of acute intestinal obstruction. There is no question but that by far the largest percentage of

cases can be correctly diagnosed early if the physician apply himself and use those everyday methods available every where and at all times. The careless use of morphine cannot be too severely condemned. In spite of the facts that all students of medicine have been cautioned against it and that the disastrous results of folly in this matter are frequently seen by the practitioner this pernicious habit still thrives. It is only by continuous stern criticism of the offender that we may hope to curb this undisciplined practice.

I heartily agree with the speaker as to the use of the X ray especially with opaque contrast media. It seems to me that the possibility of acute intestinal obstruction should be a strict contra indication to the oral use of barium. Barium enemata can be used in suspect colonic obstruction but their value must not be overrated. I have seen one case in which a roentgenological diagnosis of sigmoid obstruction was made because the opaque material would not pass beyond a certain area in the sigmoid. Operation revealed a normal bowel but an enormous gall bladder filled with large stones and extending well below the umbilicus.

In studying a case of intestinal obstruction I believe that stress should be laid upon the effort to differentiate between simple mechanical block and strangulation. When a simple block exists the symptoms are as a rule not so urgent and more time is available for a study of the case while in strangulation the symptoms are often characterized by early collapse with toxemia. Surgical interference if it is to be successful in the latter case must be instituted very early—at the end of 24 hours it is too late. When it is deprived of blood supply it requires but a few hours for the wall of the gut to become pervious to bacteria, peritoneal soiling takes place and a highly toxic condition obtains which is allowed to exist for over 12 hours invariably leads to death in spite of surgical interference. In this type of case there is often an early fusion of mechanical and paralytic ileus.

In case of pure mechanical block haste may be subservient to careful study and preparation of the patient and possible conservative treatment. As an example let us consider a patient with symptoms of simple mechanical block coming on after an operation for perforative appendicitis with the wound discharging considerable pus. Good surgical judgment would possibly frown upon entering the peritoneal cavity in such a case unless absolutely necessary. I have seen several cases of this type all very closely observed which were relieved spontaneously and to date have remained well. I have operated upon 1 patient 8 days after the onset of mechanical block following a suppurative appendicitis and the patient who had been receiving proper pre-operative care came to the operating table in excellent condition and withstood the operation very well. I do not wish to advocate waiting 8 days but simply to illustrate that haste which might involve a mistaken diagnosis or unnec-

essary operation is not warranted in this type of disease.

Dr Holden did not specifically call attention to one phase of the surgical treatment which I am sure he uses and which is often a life saving measure—the pre operative preparation. In the neglected cases of simple mechanical block and in case of strangulation a high grade toxemia exists there is marked dehydration often with starvation and the blood chlorides are frequently low. These patients are poorer surgical risks than they appear to be. This I have learned from a few bitter experiences. The repeated introduction of physiological salt solution or Ringer's solution will materially assist the patient to withstand the contemplated operation. When starvation is present glucose solutions given intravenously are of material benefit. Perhaps a blood chloride estimation may be worth waiting for and if the blood chlorides are very low the introduction of hypertonic salt solution before the operation may be a wise procedure.

As far as the operative procedure is concerned the type of case to a considerable degree dictates the nature of the procedure. I try to enter the abdomen in the vicinity of the obstruction if this can be determined pre operatively. If I may be pardoned I cannot agree with the speaker in performing routine evisceration and gut drainage. I do not use or advocate evisceration except in case of necessity. My own experience has taught me that if the abdomen can be opened the bowel held aside the obstruction found and relieved and closure done without further manipulation the patient will have a smoother convalescence than when evisceration is done and an effort made to empty the bowel. I cannot get away from the impression that the insult to the gut coincident with evisceration and drainage is more than the good such a procedure can possibly accomplish. Moreover I have never been able to remove what to me seemed a quantity of intestinal contents sufficient to be of any distinct benefit to the patient. This impression is arrived at in spite of the fact that laboratory workers tell us the absorption of toxic material depends upon the pressure within the imprisoned bowel. So long as the bowel wall which is proximal to the obstruction has the power of contracting it will empty its contents into the distal gut. I doubt if removing some of the fluid content when the gut is paralyzed will benefit the patient to a degree commensurate with the shock of the procedure. In those cases in which evisceration is necessary either because of the enormous distention or because of the surgeon's inability otherwise to find the obstruction an attempt to empty the bowel may be warranted because it does at times help in the replacement of the intestines.

Highly toxic patients with high intestinal block are extremely ill and will tolerate little surgical interference. In such cases immediate operation brings on a fatal issue. If we hope to save such patients it is only through the careful pre-operative preparation—the intravenous introduction of copious

quantities of Ringer's solution, hypertonic salt solution and glucose. Insulin may be used in well controlled cases. The stomach should be kept empty by continuous aspiration. It is surprising to see the improvement such a regimen often brings about in the condition of the patient.

When operation is carried out in case of low obstruction with marked distention approaching a paralytic ileus it is often a question whether a hurried enterostomy is not a wiser procedure than an attempt to relieve the obstruction if the latter is a time consuming method. Moreover, an enterostomy may be a valuable adjunct even after the obstruction has been relieved. In case of strangulation, if the bowel is found not viable the question again arises as to whether a resection should be done. I believe that if there is a considerable question in the mind of the operator, he should decide in favor of bringing the strangulated loop out of the abdominal cavity and intubating the proximal orifice, leaving the repair for a subsequent operation. Under these conditions the ability to evaluate the patient's tolerance to withstand a contemplated operation requires close study and keen surgical judgment.

I wish to thank Dr. Holden for bringing this most important surgical condition to our attention. Surely he is correct in this statement that no field in abdominal surgery challenges our attention more than this.

DR LESTER R. DRAGSTEDT, Chicago. This paper by Dr. Holden is so definite, clear and correct in all of its essentials and emphasis has been placed so properly upon the necessity of early diagnosis and immediate surgical treatment that I am sure the author will bear with me if I attempt a few explanations from experience in the laboratory. I am disappointed that he has found so little help from the work of the experimental surgeons and yet some of the questions he raises have been already answered.

It is becoming daily more clear that we must sharply differentiate between obstruction in the upper intestine and obstruction lower down. In the former case the obstructing agent is most commonly scar tissue, contraction or occlusion from intra-intestinal or extra-intestinal tumor or bands in which there is little or no injury to the bowel circulation either directly or through increased intra-intestinal pressure. In such cases the cause of morbidity and death is the failure of reabsorption of the water and salts secreted in the gastric and pancreatic juice.

I have put the question of the importance of the reabsorption of gastric juice to crucial test in some experiments reported at the recent Physiological Congress in Boston. The stomach was short-circuited in such a way that its secretion was not inhibited but the gastric juice passed directly to the exterior instead of into the intestine. There was no obstruction in the alimentary tract of these animals and yet they died very promptly with the same changes in the blood chemistry as develop in

a case of simple high obstruction. The loss of gastric juice through failure of reabsorption in the lower intestine could be regularly compensated for by the intravenous administration of Ringer's solution or 0.9 per cent sodium chloride. In every case of high obstruction and in many low obstructions the first obligation of the physician is to restore to the body the lost water and salts and then to correct the condition which prevents the reabsorption of digestive juices in the lower intestine.

In lower obstructions, however, in which there is a considerable length of absorbing intestine between the stomach and the obstruction site, this factor of failure of reabsorption of the digestive juices plays a less important rôle. In these cases injury to the vascular supply to the intestine through distention or strangulation, is more apt to occur and this condition permits the absorption of the toxic substances which have accumulated in the obstructed bowel. It is to be emphasized that these substances are not appreciably absorbed by the normal mucosa and no concern need be felt if they are discharged into the collapsed distal intestine after relief of the obstruction. My experiments have convinced me that the factor which permits their absorption from the obstructed proximal loop is the development of increased intra-intestinal pressure which secondarily interferes with the circulation of the mucosa. Treatment is accordingly directed toward the relief of this pressure and herein lies the only virtue of enterostomy and of course, of the removal of such intestine as is irrevocably damaged.

DR FREDERIC A. BESLEY, Waukegan, Illinois. Dr. Holden's masterly presentation of the subject of surgery of intestinal obstruction offers for discussion one of the most important problems with which the surgeon has to deal. This problem usually presents itself as an emergency and taxes all the ingenuity and surgical experience of the surgeon, for upon his judgment as to proper procedure may depend the life of the patient. The condition is somewhat unique in that it presents the twofold pathological situation involving both the biochemical physiological disturbance within the canal and in the intestinal wall and the mechanical anatomical obstruction to the fecal stream. There has been much discussion of this involved and intricate subject and a wide variance of opinion exists as to the advisability of invariable drainage of the content of the bowel by enterostomy, with or without dealing with the mechanical obstruction at the time or of attack upon and correction of the direct cause of the blocking leaving the intestine intact. Obviously, each case is a law unto itself with the multitude of signs, symptoms and differences in the pathological condition. The judgment of the surgeon as to the better method is influenced by all of this. An experienced surgeon was once asked what procedure he followed in these cases. He replied that sometimes he did just an enterostomy but occasionally he did not and instead confined himself to the relief of the mechanical obstruction, with or without opening the



bowel. He declared that no matter which operation he had done he frequently had regrets later and wished he had proceeded differently. Dr. Holden's criticism and condemnation of the use of morphine is timely and well stated. It is a striking commentary on the slowness of education that such a warning is necessary for the danger of masking symptoms by giving morphine in acute abdominal pathology has been taught for years. He very properly emphasizes the essential importance of the time element for delay leads to dehydration and exhaustion of the patient.

The differences of opinion and controversy relative to the exact site of the formation of the more virulent toxins, whether in the jejunum or in the blocked and distended canal proximal to the point of obstruction still exist. It would appear rational and logical to assume that toxic changes do occur in the distended gut and this deduction is borne out by the experimental work of several investigators. If this be true a simple jejunostomy does not provide

the best method of drainage. The stripping, and the emptying of all of the content of the bowel from the duodenum to the obstructed segment would seem to approach the ideal procedure.

One comment on this manipulation is justified. The stripping of the intestines between the fingers should be done with the greatest gentleness to avoid the compression of the wall and the forcing into the lymphatic and blood streams of the toxins that have formed and accumulated within the layers of the bowel itself. Experience teaches that in many cases it is unnecessary to do a complete evisceration of the bowel en locating the site of the obstruction for the finding and following up of the thin ribbon of collapsed bowel distal to the blocking frequently leads one easily and quickly to the offending pathology.

Dr. Holden deserves great credit for his thorough consideration of this subject. He has worked out each detail with meticulous care and the excellent results that his statistics present are most convincing and justify his deductions and his conclusions.

ORATION ON FRACTURES<sup>1</sup>

CHARLES L. SCUDDER M.D., F.A.C.S., BOSTON

THE institution by the American College of Surgeons of an oration on fractures is significant, it shows a growing appreciation of the importance of this department of surgery. I value greatly the honor which has been placed upon me in asking me to deliver this first address.

At present no other subject in surgery is of more vital concern to the public and the medical profession than fractures.

Many problems which arise in the treatment of fractures are yet unsolved. Let me enumerate a few:

1 The securing of accurate records of clinical observations, which can serve as the basis for dependable conclusions.

2 The understanding of the relation of fractures to industry.

3 The necessity for sound ethical practices.

4 The further development of new methods of treatment.

5 The proper treatment of the rapidly increasing number of bizarre and complex types of fractures, the results of railroad, motor vehicle, and airplane accidents. During 1928, about \$41,000,000 was spent by the railways of the country for the treatment of personal injuries, and of that amount \$20,000,000 was paid for the treatment of fractures.<sup>2</sup>

6 The advancement of direct and indirect research into the processes of repair, involving physical, chemical, physiological, and pathological studies, which opens up fascinating and promising fields.

These problems are the most momentous faced by the surgeon today.

The art of surgery is far in advance of all the sciences upon which its future depends. Until they stand abreast, the progress of surgery will be slow. Some day science will outdo the art and take its legitimate place as the basis of sound treatment. By swift changes in progress, surgery has become safe

and still more safe, until it can be asserted that a further increase of safety for the patient can depend only upon an earlier access of the surgeon to him.

"The chief risk in surgery today comes from delay. Surgery has been made safe for the patient, we must study to make the patient safe for surgery." (Moynihan)

Chronic duodenal and gastric ulcers were permitted to advance to perforation, peritonitis, and fatal hemorrhage until comparatively recent times. Fractures are now wittingly allowed to go beyond the time at which successful treatment may be instituted. Such delay in the initial treatment of a fracture forever precludes the possibility of preventing disabling deformity. In some of these cases even death itself might be preferred to the permanent disability, with which we all are familiar.

In our attitude toward fractures, we must eradicate from thought certain deeply rooted conceptions of disease.

There is no incubation period in a fracture. In the ordinary case of fracture, there are not 6 days in which to wait for an organism to react. The accident is instantaneous. The fracture is present. The reparative processes begin immediately. Therefore, treatment should begin without delay so that the reparative processes may be facilitated instead of hindered.

By treating a fracture instantly you treat the fracture. By treating a fracture after delay you treat a fracture plus complications.

Early treatment is easy. Delayed treatment is difficult. Delayed treatment is dangerous. Late treatment is lamentable.

At this time, may I sketch briefly for you the treatment of fractures? I should like to stress one phase of treatment and to say a word concerning the relative usefulness of the two great methods of treatment.

The successful treatment of fractures is predicated upon the correctness of one's conception of the four ends to be achieved. These

<sup>1</sup>Findings of the Bureau of Railroad Economics, based upon the report of the Interstate Commerce Commission.

<sup>2</sup>Delivered before the Clinical Congress of the American College of Surgeons, Chicago, October 14-18, 1929.

four goals, if you please, may be called the four R's of treatment, viz (1) the restoration of the individual, (2) the reposition of the fragments, (3) the retention of replaced bones, and (4) the return of the injured man to society.

When I remember that I am speaking to an audience of trained surgeons, I do not expect that I shall say anything that is new to you. The baldest statement of what is meant by the restoration of a case of fracture is sufficient.

By restoration I understand the surgeon's mental picture of the entire progress of the case, from its inception to a complete cure. In approaching a case of fracture the surgeon will, as a matter of course assemble all available data—everything relevant to the case—as he does in preparation for any other surgical procedure. A perfect host of conditions may impose themselves about a fracture and postulate treatment. To decide upon the initial treatment is often most difficult. When the surgeon has taken account of every adventitious circumstance and correlated all data he will note the exact lesion as revealed by the X-ray. He will choose a treatment as closely adapted as may be to all the existing conditions. He will look into the future; he will visualize the initiation and the progress of the treatment chosen.

This imagined restoration of the patient includes far more than the prognosis. It includes the progress of the patient from the time of the injury through completed treatment.

The restoration of the patient is the vision of the reasons underlying the surgeon's choice of a particular method of treatment. This conception of the restoration is the backlog of all treatment, it is the foundation of successful fracture therapy.

The habit of the active utilization of well understood principles is the final possession of wisdom. The really wise surgeon establishes treatment in consonance with his idea of the restoration of the case.

Unless the restoration concept is sound treatment cannot be sound. The treatment selected will be not only correct but the best

possible if based on a clear vision of the restoration of the case. Concerning reposition, I shall have something to say in a moment.

The retention of reposed fragments must be accomplished in the treatment of all fractures, and is so effected as to permit eventually the greatest possible active movement in involved or adjacent joints.

The return of the patient to society means the progress from job to job, that is, from job lost to job secured. The return includes (a) the rehabilitation of the injured part, (b) the restoration of joints, muscles, tendons, nerves, and circulation, and (c) the recovery of function by the damaged part to the greatest degree possible, as early as possible.

All fractures are treated by non-operative or operative methods, or by combinations of these two. The procedures available in the non-operative treatment are (1) traction and counter traction, (2) manipulation, (3) pressure and counter pressure, (4) leverage and (5) rotation.

Traction and counter traction may be applied by (a) gravity, (b) manual means, (c) skin hold, and (d) block and pulley, with hitch about the ankle or wrist, intermittently with or without electrically driven motor, and (e) skeletal attachment.

It is my firm conviction that a chief cause for poor results in the treatment of fractures lies in the failure to recognize certain mechanical forces and in the inappropriate imperfect and inadequate application of the available forces of traction and manipulation. Each of the ways mentioned for securing traction in the use of the non-operative method may be attended by dangerous consequences. To employ correctly non-operative methods of reposition requires training, a natural mechanical sense, skill, devoted interest and a good conscience.

May I exhibit now a series of cases of fracture treated by non-operative methods? (At this point were shown 40 slides of cases of fracture treated by non-operative method. Each case exhibited shortening and deformity. The slides presented the condition immediately after the accident and again following the treatment.)

These patients were each and all seen early, there was no delay, and each received treatment by non operative methods, well conceived and well applied. The four R's of treatment were ideally carried out. The results are good. The patients were treated in different clinics<sup>1</sup> throughout the country, and undoubtedly could be duplicated in the experience of many here. These cases illustrate splendid achievement. Such results are possible by the use of the non operative method and a large proportion of all fractures may be so treated with success.

The general practitioner or general surgeon first treats most fractures. He may properly and safely continue to do this, provided he is familiar with simple adequate emergency treatment and is also aware of his own limitations.

The great difference between the non operative and operative treatment of fractures lies in the procedure of repositioning the fragments.

The restoration, the retention, the return to function, all are common to the two methods. The repositioning of fragments is indirect by one method, and is direct by the other method.

Twenty years ago, at the time of the popularization and exploitation of the operative treatment of fractures, I said in Atlantic City, in opening the discussion of Sir Arbuthnot Lane's paper, "We are not ready for the popularization of the operative fracture treatment in this country. We

should advance fracture treatment by developing non operative methods." Gentle men, time has proved that that opinion expressed in 1909 was correct.

Today, I believe the situation in this country is changed and is as follows. The operative treatment of fractures has become a firmly established practice. It is based upon necessity, asepsis, and a clearer knowledge of the pathology of repair. It is a safe and sound treatment. It is no longer a method of last resort. It is often the method of primary choice. The results of such operative treatment when safeguarded and carried out by competent men are brilliant.

Today the non operative treatment of fractures properly applied by skilled and trained practitioners, gives superb results, as witness the cases briefly shown you tonight.

When one considers the extent to which the present acknowledged fundamentals of both the non-operative and operative treatment of fractures are neglected by some members of the surgical profession, it is difficult to restrain a savage rage.

My theses tonight are

1 That surgeons must demand the early treatment of fractures

2 That the non operative methods of reposition used are entirely inadequate

3 That when proper non operative methods are used, good results are obtained

The two great methods of treatment available, the non-operative and the operative, are developing and being perfected to such an extent that a satisfactory choice of treatment can be made only by the interested and skilled surgeon.

<sup>1</sup>The Beekman Street Clinic, the clinic of James Worcester and Robert Kennedy, New York; of Earle Conwell, Park 111 Alham, of Arche Hall, Detroit; of John Moorhead, New York; of George Hawley, Briceport; Con. extract of W. H. Campbell, Memphis; Ten. once said, I like Ma-a-huseta General Hospital, Boston.

# THE INCIDENCE OF CANCER AMONG THE INDIANS IN THE SOUTHWEST<sup>1</sup>

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**M**EDICAL opinion is unanimous that cancer is seldom, if ever found in full bloods of the Indian race. Many physicians who have spent several decades in the reservations of the Southwest believe that cancer never occurs in a full blood Indian. Hrdlicka in 1906, and Levin in 1910 came to the conclusion that malignant tumors were rare in the American aborigine.

The opportunity was afforded me during the past summer to visit a number of the Indian groups in northern New Mexico and Arizona, and it appeared opportune to seek information upon cancer incidence and if found to be low, to find an explanation for it.

I wish to make it clear that this brief paper is not based upon any physical examinations made by me, but it seemed that a survey of the subject, with the data at hand might provide a fruitful topic for our consideration.

I was able to interview quite a number of physicians and trained nurses in the field, as well as intelligent wives of traders and school teachers, who had spent years among the Indians. Through the friendship of my courier with the Pueblo inhabitants, I was able to enter many homes and talk with the Indians themselves. Whenever I heard of an individual suffering from cancer and I asked the question whether the patient was a full blood or mixed blood Indian the answer was almost invariably "mixed blood." At Keams Canyon, Arizona Dr D G Lynwalter told me that he had seen 4 cases of unquestionable cancer in Indians but that none of the diagnoses had been confirmed histologically. The first 3 cases occurred in mixed bloods but the fourth patient was an Indian woman suffering from cancer of the breast and he was reasonably certain that she was a full blood Indian. The patient disappeared when operation was suggested.

Dr Martin, of Taos, who is completing more than 35 years of medical service with the Indians of that locality, said that he had never

seen a case of cancer in a full blood Indian. Hoffman, in 1928, in an excellent contribution, came to the conclusion that cancer did occur in full blood Indians, but that the incidence was extremely low, and Miss Jones quoted by Hoffman was of the same opinion. She corresponded with a large number of doctors in the field and it is surprising how few cases of cancer were reported. The population of the Navajo Reservation is 30,000. One of the best hospitals in this area is the one at Fort Defiance, Arizona. From 1910 to 1927, this institution admitted but 27 cases of malignant tumor, of which 22 were carcinoma, although this hospital is fairly accessible to perhaps two thirds of the Indians on the reservation. One interesting case in this series was that of a full blood Navajo woman, with carcinoma of the breast, who was operated upon by Dr Polk Richards. A confirmatory histological diagnosis was made by Dr Robert Greenough, of Boston, so that there is little doubt that carefully checked observations and diagnoses would demonstrate cases of cancer in full bloods.

Great difficulty exists in determining the cancer incidence of such a primitive people. The Indian is reticent and suspicious of the white man. His long series of unfortunate experiences, as civilization has pushed him aside, have added to his unwillingness to cooperate. The religious practices and prejudices of the Indian, bound up closely with the activities of the medicine men, have held him aloof from medical care by the white race.

Until recently the type of medical service furnished the Indian population of the Southwest has been of poor quality. The few hospitals of the area are widely separated. Those that do exist with one or two exceptions, are poorly equipped. Records and case histories are in many instances incomplete or lacking altogether. Although the medical personnel contains some excellent men, the hospitals are inadequately staffed with doctors as well as

nurses. The X ray equipment is often obsolete. Laboratory facilities for tissue examination and study are seldom available. The inhabitants of the territory not immediately adjacent to the hospitals receive little medical care.

In justice to the medical staffs of hospitals serving the Navajos, one must bear in mind their nomadic character, which makes consecutive observations often impracticable. Indian names are recorded with difficulty, and the patient may give either his Indian or his Americanized name. Among the Pueblo Indians there are few well organized hospitals. The one at Taos, under the direction of Dr. Martin, is an exception.

Hoffman has pointed out that a relatively large number of Indians die from unknown causes, the figure being 18 per cent for the Indian registration area in 1925, this area not including Oklahoma, New Mexico, or Arizona. Indian prejudice and religion prevent the obtaining of autopsy material, resulting in the loss of much valuable information.

No accurate census of the Indian population has been made since 1910. Statistical data collected under such conditions must be of little value, and the exact proportion of full and mixed bloods is unknown.

Any effort, therefore, to determine the incidence of cancer in the Indians of northern New Mexico and Arizona is attended with difficulty, and conclusions reached may be inaccurate or incorrect. If one grants that the evidence, such as it is, points to a low cancer incidence, an explanation should be sought in sociological and clinical rather than in purely racial, factors.

There is little doubt that the Indian race is shorter lived than the white. One sees many Indians with all the outward signs of advanced age and there is no question that some are long lived, but the proportion is smaller than in the white race.

Infant mortality is very high. I visited many Indian homes in which 3 or 4 children had been born and only one survived, the deaths having occurred in infancy. Few Indian families have more than 2 or 3 children and many but 1. The hygiene, feeding and general care of Indian infants appear to be so

poorly managed that one marvels that more do not succumb.

Tuberculosis causes the greatest number of deaths among the Indians of this region. In the total registration area, in 1921 to 1926, 22 per cent of the reported deaths of Indians resulted from tuberculosis, as compared with only 7 per cent of the deaths among the white population attributed to that disease. The prevalence of tuberculosis was apparent everywhere. Many special hospitals admit only tuberculous patients, and I frequently encountered the disease in some general hospitals.

Considering the very high infant mortality and the alarming loss of life from tuberculosis, pre eminently a disease of youth, one could not help feeling certain that fewer Indians than whites reach the cancer age.

If we consider cancer as it occurs in various regions of the body, what factors may be responsible for a lower or apparently lower incidence in the Indian?

Epithelioma of the skin is an exceedingly rare disease. This form of cancer is readily accessible for examination and ought to be apparent, if it exists, in the Indian. One might reasonably expect to find cutaneous cancer in this race, because of the prolonged exposure of the Indian to the sun's rays, but it is possible that the amount of pigment in the skin serves as a protection. One Indian trader with whom I talked had seen an old man with an extensive lesion of the side of the face adjacent to the nose, who later succumbed to the disease. His description of the growth would pass very well for a basal cell epithelioma, but such evidence is inconclusive.

Epithelioma of the lip is seldom encountered. The Fort Defiance Hospital admitted between 1910 and 1927 but 1 case of cancer of the lip, and that in a woman. The Indian has smoked for generations. I found them always glad to accept cigarettes and they smoked them with avidity, but their supply of tobacco is apparently limited and they do not indulge in the continuous smoking which is the habit of many of our own race. Persistent repeated trauma to one segment of the lip from excessive smoking is apparently infrequent in the Indian.

Five factors contribute to the production of intra oral cancer in the white race, namely (1) jagged irregular teeth, (2) carious teeth and infected mouths (3) gold filled or gold crowned teeth, (4) persistent tobacco smoking, and (5) lues. The two first are found in the Indian. He has better teeth than the white man, as he is called upon to masticate coarser foods and partakes less often of sweets, but nevertheless, jagged, irregular, and carious teeth, and infected mouths are not unusual. Little dental work has been done for the Indians, and few of them have filled or capped teeth. Persistent smoking is less often encountered than in the white race and all agree that lues is a rare disease among the Indians except at points of contact with civilization. It would appear probable that 3 of the 5 factors contributing to intra-oral cancer are seldom present in the Indian.

The apparent infrequency of cancer of the breast may be explained upon two grounds.

1 The Indian women nurse their babies over much longer periods than is the habit of civilized races, in which infants often are weaned shortly after birth. This practice brings about an interruption of physiological lactation and there is considerable evidence to suggest that such an interference with the normal mammary function may favor the development of carcinoma.

2 Indian women manifest such unwillingness to subject themselves to examination by doctors of the white race that many cases of the malady may be undiscovered.

Cancer of the uterus is seldom recognized. Children are born without the aid of physicians, for the practice of obstetrics is carried on by native women, or the mother may be unattended when she bears the child. Under these circumstances cervical lacerations must occur. It is certain that Indian women are no more cleanly in their habits than those of the white race and the non specific vaginal flora should be identical. Gonorrhea is infrequent in the Indian but a causal relationship between this infection and the development of carcinoma is questionable. The unwillingness of the Indian woman to submit to pelvic examination would appear to be an important element in attempting to determine the facts

as it prevents disclosure of the disease. Moreover, it seems reasonable to believe that many Indian women dying from 'unknown causes' may have succumbed to uterine cancer.

Cancer of the stomach is rarely discovered. The habits of the aborigine may contribute to a lower incidence of gastric carcinoma. The food is coarse in texture and requires more complete mastication, which results in a better admixture with the salivary juices. The flour which the Indians use is less refined than our own. Their meat is sun cured, is firmer and must be chewed more completely than the cooked meat of civilized man. Salt is sparingly used. Indulgence in iced drinks is slight, and alcoholic beverages are not often taken for the Indian is not as persistent a drinker of alcohol as the white man. The Indian does not use excessively hot food or drinks and he is a comparatively light eater. All of these factors may combine to account for a lower incidence of gastric cancer. Nevertheless the large number of Indians dying from 'unknown causes' may well include a considerable percentage of undiscovered cases of cancer of the stomach.

Cancer of the rectum ought to be less frequent in the Indian race. The large amount of physical exercise taken by the Indian is in marked contrast to the usual sedentary mode of living of civilized man and elimination must therefore be more complete and automatic. They are without access to the modern toilet which induces straining at stool, hemorrhoids and constipation. The habit of squatting in the act of defecation is a more normal physiological position resulting in less rectal irritation. For these reasons one might expect cancer of the rectum to be less frequent than in the white race.

#### CONCLUSIONS

The following conclusions may be drawn from this brief study.

1 There appears little doubt that in certain regions of the body, namely, the skin, lip and intra oral cavity, cancer incidence is lower among the Indians than in the white race.

2 The same statement may be true of the incidence of cancer of the rectum.

3 On theoretical grounds, one would judge cancer of the stomach to be less frequent in the Indian than in the white man

4 If the interference with normal lactation, as practiced in the white race, is proved to have a causal relationship to the development of cancer of the breast, this disease should be found less often in the Indian race than among white peoples, otherwise, one would expect it with equal frequency

5 If it could be demonstrated that gonorrhea—a disease rare among the Indians—is an important factor in the production of cancer of the uterus, the incidence of the latter disease in the Indian race should be less than in the white race. If such a premise is incorrect, then the frequency of cancer of the uterus should be equal in the two races

#### SUGGESTIONS FOR FURTHER STUDY

It is obvious that dependable clinical and laboratory data on such a subject are sadly lacking. Complete reorganization of the medical care of the Indian would appear necessary if the true facts on cancer incidence in this race are to be discovered. Moreover, no plan to obtain the information desired can be put into operation unless it includes an effort to improve the mutual understanding between the two races

The following suggestions along constructive lines are therefore offered for your consideration

1 A system of medical registration should be instituted in which both Americanized and Indian names, and the presence of full or mixed blood should be recorded

2 The present general hospitals should be increased in number and provided with modern surgical and X-ray equipment

3 A centrally located laboratory for routine examinations and research should be organized, available to the hospitals of the entire area

4 The present hospitals for tuberculosis and trachoma should be reorganized and enlarged, thereby making it possible to rid the general hospitals of such cases

5 The medical and nursing staffs of the existing hospitals should be increased, and, whenever possible, younger practitioners with leanings toward scientific research should be added

6 Health centers might well be established on the Navajo Reservation and among the Pueblos

7 Adequate social service in conjunction with hospitals and health centers is, above all else, urgently needed to make effective the medical care of the Indian

I believe that the execution of such a program would result in a vast amount of much needed service to the Indian and the acquisition of much valuable information upon the subject of cancer incidence

#### REFERENCES

- 1 HOFFMAN F. L. Cancer among North American Indians. Newark 1928
- 2 HADJICKA A. Diseases of the Indians, more especially of the Southwest United States and Northern Mexico. Washington 31 Ann 1905 iv 372-304
- 3 LEVIN I. Cancer among the American Indians and its bearing upon the ethnological distribution of the disease. *Ztschr f Krebsforsch* 1910 ix 422-435



THE RECOGNITION OF EARLY CERVICAL CANCER<sup>1</sup>

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ALL the statistical studies presented at this meeting and all those which have been made for many years past point, as inevitably as does the compass to the magnetic pole, to one crucial conclusion, viz., that the duration of the cancer, far more than any other single factor, determines the fate of the patient. This is true regardless of whether radium or surgery is the therapeutic agency employed, so that on this one point all those engaged in the fight against cancer can meet on common ground.

My own contribution to this symposium will be limited to a brief discussion of the means available for the recognition of the very early cases, the group in which we have every right to expect a large proportion of cures. The percentage of permanent cures in this group is far greater than the percentage we are now obtaining in cases as they actually come to us. This, therefore, is the strategic line of advance which must suggest itself to all of us.

Two plans of action are open to us. We need not make a choice, for both must be utilized. One of these, of course, is the education of women as to the significance of abnormal bleeding and discharge, more particularly beyond the age of thirty.

This movement, begun within very recent years, is gaining great momentum under the stimulating sponsorship of the American College of Surgeons, the American Medical Association and the American Society for the Control of Cancer. Fundamental as is this educational campaign, I shall not discuss its methods or results, for I prefer on this occasion to address myself to a discussion of the need of a corresponding effort to rouse our own professional ranks, so that cancers in the earliest stages will be dealt with in the same alert fashion as the late cases.

The educational campaign will do only one thing. It will bring an increasing number of women with suspicious symptoms to the

doctors of the country for diagnosis and advice. It would be a sad commentary on our profession, if these women, alert and confident enough to seek advice, were met by apathy or lack of thoroughness and conscientiousness on our part. This criticism has already been made with regard to another great medical movement, that advocating the periodic health examination of presumably healthy individuals. We must not give cause for similar criticism as to our cooperation with those seeking to protect themselves against cancer. I need not tell this audience how morbid the dread of cancer is in the minds of many individuals, but no such patient should fail to receive a sympathetic bearing and, if necessary, examination from his medical adviser. Such a consultation should always include a simple exposition of the subject to the individual patient, reassuring her when reassurance is called for, and advising her sanely as to how she may protect herself in the future. When all our consultations become educational and preventive in this sense, a great step forward will have been taken.

No physician today is ignorant of the possibly ominous significance of abnormal bleeding in women approaching or at the middle period of life. Furthermore, no physician except the unteachable few, will fail to make at least a simple pelvic examination in such cases, or see that someone else does. Nor is there any great risk that cancer will be overlooked, if such an examination discloses a large cauliflower growth of the cervix or a foul excavated cancer ulcer. But how much benefit accrues to the patient even if such a lesion is discovered? Her chances for life are relatively small. And yet the concept of cancer held by many of our profession is just the type of lesion I have pictured, much as the old clinical picture of appendicitis was really that of the complicating peritonitis that follows per-

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foration and too often is, in turn, followed by death.

This, then, is the motif of my paper, i.e., that the profession should put aside the picture of what is really the late cancer lesion, and familiarize itself with the picture of the early cancer. In its early stages a carcinoma of the cervix is not a conspicuous lesion. It appears usually as a small hardened area in one or other lip of the cervix. The surface is granular, bleeds on slight touch, and may, even in early stages, be covered with fine sprout like outgrowths. In other cases, as where a cancer develops in an old erosion or ectropion of the cervix, the cancer area may be more diffuse. The more experienced the examiner and the more advanced the lesion, the easier it is to detect the earmarks of malignancy.

But this, after all, is not the point I am striving to stress, for we cannot expect every family physician in the country to assume the responsibility of saying whether or not a given lesion is an early cancer. We can, however, hope that medical men generally will appreciate what characteristics make a lesion suspicious enough to want the question definitely settled. For that matter, even the expert gynecologist cannot, from the mere clinical appearance of the lesion be sure, in a certain proportion of cases, whether he is dealing with an early cancer or with an inflammatory lesion. But he can settle the point, in almost every instance, by making a biopsy and a proper pathological examination. This means putting the patient and himself to a little trouble, but the reward is great. It may mean the recognition of a very early cancer with excellent prospects of cure. More often perhaps it means the diagnostic elimination of cancer with ensuing peace of mind for the patient and with the consciousness, on the surgeon's part, of a diagnostic problem well handled.

How much better this is than the policy of taking a chance that the lesion is not cancer and consigning the patient to a probably fatal delay if cancer really exists.

And how much better than for the surgeon to solace himself, after unnecessarily radical treatment, by saying, "Oh, well, if it wasn't

cancer, it was at least 'precancerous'." While "precancerous" lesions should be corrected, their eradication does not call for radical surgery or radium. In the vast majority of cases, very simple corrective procedures, such as radial cauterization of the cervix, trachelorrhaphy, or tracheloplasty, will suffice. But before these simple procedures are resorted to, the surgeon should be sure in his mind that cancer is not present.

It is hardly necessary to emphasize that the vast majority of cervical lesions is obviously benign or obviously malignant, so that it is only a small proportion, probably well under 5 per cent, which calls for biopsy and decisive microscopic diagnosis. But this group of very early cases, and the early cases in which, even without the microscope, the diagnosis is reasonably certain to the trained observer, together should make up a considerable fraction of our cases. Our aim should be to increase the proportion of these relatively favorable cases on the one hand by popular education, on the other by developing our skill in the recognition of the early stages.

In the diagnosis of the very early stages the microscope must make the diagnosis, rather than merely confirm it, as in the later stages. The tissue to be submitted for microscopic examination must be obtained by biopsy, the excision being not of course at random from the suspected cervix, but from the area, often quite small, which is directly under suspicion. Furthermore, the sections must be cut in such a way as to show the epithelial surface, otherwise the examination may be not merely worthless but actually dangerously misleading.

There has been much discussion as to the possible danger of biopsy—whether or not it may permit of rapid dissemination of cancer cells. As regards the field of cervical cancer, there is no evidence as yet to substantiate this fear. Furthermore, even if there were some risk, we would resort to biopsy any way in the group of cases in which the diagnosis cannot be made in any other possible way. The information to be gained is of such vital importance to the patient that it far more than counterbalances any supposed

or real danger of biopsy. Nevertheless, in view of this possible element of risk, it behooves us to take such precautions as appear indicated to circumvent it, such as the cauterization of the edges of the biopsy wound, the complete excision rather than incision of suspicious areas when possible, and so on.

The value of biopsy is nullified unless the pathological examination is made by one skilled in the interpretation of the rather specialized pathological pictures encountered in the cervix. Mistakes in the diagnosis between malignant and non malignant disease are more readily made here than in almost any other tissue, because of the very great frequency of inflammatory lesions which resemble cancer in many ways and which are nevertheless perfectly benign. These peculiar pictures are due chiefly to the tendency of the squamous epithelium to invade the deeper tissues. I shall show some of these pseudomalignant pictures on the screen but shall not discuss them at any length, as I have considered this whole subject in a paper which appeared in the October 1929, issue of the *American Journal of Obstetrics and Gynecology*. It should be emphasized, however that such misleading pictures are exceedingly common, especially with chronic endocervicitis and cervical polyp, and that they have often been mistaken for cancer, but that the trained pathologist can, with rare exceptions, make the differentiation correctly. In the paper above alluded to, I have collected figures indicating the trustworthiness of biopsy and proper microscopic examination of cervical tissue in differentiating cancerous from non cancerous lesions, as determined by the subsequent histories of patients who have been subjected to this procedure.

In this field of work, the gynecological pathologist so called, has a genuine advantage over the general pathologist who does not have equal opportunities for familiarizing himself with this rather specialized type of lesion, even though somewhat analogous pictures are at times encountered in other organs. This is of course no reflection upon the ability of the small army of tissue patholo-

gists who are rendering such excellent service in hundreds of hospitals, large and small throughout the country. Nor should it be interpreted as a "holier than thou" attitude on the part of gynecological pathologists, who, in their turn would be woefully at sea if called upon to make differential diagnoses in lesions of the bones, nervous system, and other specialized fields.

The practical question which must suggest itself to the surgeons in this audience who are doing such conscientious work in communities perhaps far removed from specialized workers in this field will naturally be as to how, in view of what I have said, they can be sure of the correctness of those diagnoses which depend upon microscopic examination of suspicious tissues. Fortunately the aggregate number of such doubtful cases is relatively small and in these the conscientious surgeon and pathologist can always enlist to share their responsibility, others who presumably have larger opportunity for studying such lesions. Consultations in the difficult cases of pathological practice serve a purpose no less useful than consultations in clinical practice.

I have said nothing as to the clinical symptoms which should lead the physician at least to suspect the possibility of cancer for these are familiar to you all. Nor have I discussed the question of prognosis on the basis of the histological characters of the constituent cancer cells as determined by the microscope. This question has been studied by Broders, Martzloff, and others but it cannot be considered as finally settled. Some of the systems of histological classification suggested are suitable and rational others are intricate and unimpressive. The histological malignancy index, as given by one writer is based upon nearly twice as many "points" as the famous fourteen with which President Wilson prodded the German

#### SUMMARY

To summarize the facts I have tried to stress, and to include a few others which limitations of space will not permit me to discuss at length I shall set forth, in rather aphoristic fashion the following statements:

1 The diagnosis, even the early diagnosis, of late cervical cancer is easy, but it confers little benefit on the patient, for her chances for cure are poor. It can usually be made by the simplest kind of pelvic examination.

2 The diagnosis of early cervical cancer is often difficult, but it means much to the patient, as it gives her a relatively good chance for life. It requires experience, a careful pelvic examination, including the use of the speculum in a good light, and, in a certain proportion of cases, biopsy and microscopic examination.

3 Biopsy is *not* necessary if the cervix is of normal appearance, or if an area of erosion or eversion is pink, smooth, firm, and non-vascular, without areas of either induration or friability.

4 Biopsy is indicated if there is an indurated area on either cervical lip, especially if the overlying surface is granular, vegetative, or ulcerated, and very vascular. It is also indicated if, in an erosion or ectropion, there is a hardened or raised area, with vascularity, sponginess or tendency to ulceration of the surface.

5 Biopsy may be performed with a sharp knife or punch followed by searing of the wound edges with the cautery.

6 The tissue should be excised from the most suspicious area, and the sections should be cut in such a manner as to show the mucous surface. It is desirable to cut a number of sections at different levels in the block.

7 The pathological examination should be made by a competent pathologist preferably by one thoroughly familiar with the special pictures encountered in this field. In most cases the diagnosis is easy in some

cases difficult, and in a very small *residuum* it may be impossible. In such cases the proper procedure is to wait for a few weeks and then repeat the procedure.

8 The great majority of cervical lesions is obviously benign or obviously malignant, so that biopsy and microscopic differentiation need be invoked in only a small proportion, probably considerably less than 5 per cent.

9 If the pars vaginalis is normal in appearance, but the intracervical mucosa seems vascular or granular, the curette may reveal definite intracervical cancer, most often adenocarcinoma.

10 By a careful weighing of the clinical history, the naked eye picture of the disease, and where necessary, the microscopic findings, cancer will rarely be overlooked, even in its very early stages.

11 If, as most often is the case, the suspicious lesion is found to be benign, it should be eradicated by whatever method is best suited to the individual case. Usually some simple procedure, often of the office type, is sufficient. These lesions unquestionably predispose to cancer, when combined with the still unknown factor of individual susceptibility. Their eradication is the one important contribution we can make to the direct prophylaxis of cervical cancer.

12 From the standpoint of the general profession, the great need is a readjustment of the clinical concept of cervical cancer so as to include the early pictures as well as, and even more than the later ones. This is a contribution which the public has a right to expect of us if we are to continue our efforts to educate women as to the early warnings of cancer. Let us practice as well as preach!

# THE SURGICAL INDICATIONS FOR SYMPATHETIC GANGLIONECTOMY AND TRUNK RESECTION IN THE TREATMENT OF CHRONIC ARTHRITIS<sup>1</sup>

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SINCE numerous patients with chronic arthritis present a syndrome of vasomotor disturbance similar to that of Raynaud's disease, it occurred to us that the same type of surgical treatment employed in Raynaud's disease might prove of value in chronic arthritis. We do not propose any change in the treatment of acute arthritis, nor have we had sufficient experience to draw definite conclusions concerning all types of chronic arthritis. However, we have accomplished some satisfactory results with sympathetic ganglionectomy and trunk resection in the treatment of the periarthritic type of chronic arthritis, and these results we wish to report.

## ANATOMY AND PHYSIOLOGY

The muscular tone and caliber of the arterial system are governed chiefly by the sympathetic nervous system. Its central origin is supposed to be in the diencephalon. The impulses then pass along tracts through the brain stem and spinal cord to be transmitted along neurons, the corresponding cell bodies of which are in the lateral column of the gray matter of the anterior horn. These neurons are known as preganglionic white rami communicantes. They terminate in synaptic relations with the cells in the sympathetic ganglia. The impulses are distributed from the ganglia by postganglionic fibers known as gray rami communicantes. Those of the preganglionic fibers which carry impulses to the viscera communicate directly with thoracic ganglia and postganglionic fibers or go to make up the splanchnic nerves and terminate in the celiac ganglion to be redistributed as postganglionic fibers. The innervation of the arteries, pilomotor muscles, and sweat glands of the extremities is carried from the thoracic

lumbar sympathetic ganglia by postganglionic, gray fibers back into the spinal nerves to be distributed in somatic relation corresponding to the musculocutaneous distribution of cerebrospinal nerves. The sympathetic nervous system also contains sensory fibers which have their ganglia in the spinal cord (Ranson). These fibers reach their destinations by way of the white rami. We would also like to believe that there are sensory fibers associated with the postganglionic fibers which innervate the vessels as it is difficult otherwise to explain the sudden relief of pain following ramisection or ganglionectomy in the treatment of Raynaud's disease. Orbeli believes that the relief of pain following ramisection is due to lowering of the sensitivity to pain.

Since some muscular tonus still exists in the arterial wall after interruption of the vasomotor sympathetic nerves, Baylis has suggested that this tonus is maintained by dilator fibers which travel antidromically along the sensory spinal nerves. Davis and Kanavel have made the suggestion that it might be due to cerebrospinal innervation of the arteries. Orbeli believes that muscular tonus of the smooth muscles following section of the sympathetic fibers is maintained by the chemical reaction of the plasma. Leriche believes that an intramural ganglion and neurons must exist in the wall of the arteries. As yet there is considerable speculation as to the existence and functions of nerves other than the vasoconstrictor nerves to the arteries.

## OPERATIVE MEASURES

Jaboulay and Leriche are responsible for proposing and performing periarthritic sympathectomy in the treatment of painful gangrenous conditions of the extremities. They

assumed the innervation of the arteries to be centrifugal in distribution, or if not centrifugal, then centripetal, since there appeared to be temporary relief of the side that had not been subjected to operations. But the anatomical work of Kramer, Todd, and Potts demonstrated that the distribution was somatic and corresponded with the cerebrospinal musculocutaneous innervation. Leriche obtained temporary improvement in the extremities, the nerve supply of which had not been operated upon. One of us (Adson) explains this fact as being due to influences of postsurgical fever and temporary paralysis of the sympathetic nervous system as a result of the general anæsthetic. Royle's ramisection for spastic paralysis stimulated several neurological surgeons to try the procedure for spastic paralysis, but it was soon learned that the temperature changes following the operation were of more clinical value than the operation for spastic paralysis. One of us (Adson, 1) discovered that it was easy to overlook rami in attempting to section them and proposed and carried out complete removal of the second, third, and fourth lumbar ganglia without complication thus removing the lumbar sympathetic trunk and interrupting all of the gray rami below the first lumbar ganglion. It is true that the efferent sympathetic outflow does not enter the lumbar sympathetic ganglia below the second lumbar ganglion, but it is wiser rather to do more than is necessary than not to do enough, when an attempt is made to paralyze the vasomotor control of the arteries of the lower extremities. Sympathetic lumbar ganglionectomy and trunk resection not only produced immediate increase in surface temperature of the lower extremities but maintained the increase of surface temperature. This has been verified by repeated examination of patients over a period of more than 4 years after operation. When these phenomena became established Adson and Brown (1) applied the procedure in the treatment of Raynaud's disease and found it to be successful. The results were verified by Diez Davis and Kanavel, Fulton, Royle and others. Thereafter, cases of allied vasospastic disorders such as thromboangitis obliterans with spasm of the collateral vessels,

scleroderma of vasospastic origin, and chronic arthritis with similar vasomotor disturbances, were treated by the same procedure.

The treatment of vasospastic disorders of the upper extremities was more difficult. Brucening reported a cure of Raynaud's disease and scleroderma by performing a Jonnesco operation, removing the stellate ganglion. But we did not produce cure when we performed the Jonnesco operation, nor did cure occur when we combined the Jonnesco ganglionectomy and the Royle (20-25) cervical ramisection in the treatment of Raynaud's disease. It was apparent that the anterior approach to the cervicothoracic ganglion did not afford sufficient exposure to allow interruption of all of the efferent vasoconstrictor impulses. Therefore one of us (Adson, 2) carried out a posterior thoracic approach which permitted section of the thoracic sympathetic trunk below the second thoracic ganglion in addition to removing all of the second and first thoracic and the lower cervical sympathetic ganglia. This procedure completely interrupted all of the efferent vasomotor impulses to the upper extremities, head, and neck, thus producing the same satisfactory result previously accomplished in the lower extremities.

#### SELECTION OF CASES

In selecting patients suitable for operation we have chosen only those who seek relief for a disease that is progressive, who have failed to respond to the accepted types of treatment, such as removal of foci, immobilization, massage, and exercises, and who present the vasospastic syndrome that is temporarily relieved by baking, diathermy, and vaccines. Thus far we have not included the group of patients with arthritis due to specific disease, such as tuberculosis, gonorrhœa, or syphilis, nor have we included those patients who present destructive ankylosis. It is probable that surgical procedures may be indicated in some of these patients who are suffering with hypertrophic and destructive changes, if so, the objects would be to relieve pain to check the disease, and to assure better results from arthroplasty by improving the circulation.

The patients we have chosen are those who complained of painful, swollen, tender joints

associated with limited motion, atrophy of muscles, and loss of function, and who also complained of cold extremities, mild acrocyanosis, excessive perspiration, and aggravated symptoms during stormy weather. One of our patients described her feet and legs by saying that they felt like dead fish, thus effectively describing the cold, clammy skin of the extremities.

In order better to select suitable cases for operation we submitted all of these patients to vascular studies to determine the presence or absence of vasospasm or obliterative lesions of the arteries. It is essential to know whether or not the main arteries or the collateral arteries are patent and capable of relaxation if robbed of their vasomotor control. This is determined by Brown's 'fever test' which consists in making simultaneous readings of mouth and skin temperatures following the administration of a foreign protein. In a normal person or in one suffering from a vasoplastic disorder, the skin temperature over the digits will increase several times more than the increase of the mouth temperature where as it will be observed that in patients with arterial sclerosis or occlusive lesions the surface temperatures of the extremities are rarely much above the increase of the mouth temperature. We have also observed that the maximal increase of skin temperature over the extremities during the test is reproduced by ganglionectomy and trunk resection therefore this test serves as an index and unless the rise in temperature of the skin over the digits is two or more times greater than the rise of the mouth temperature, the patient is considered unsuitable for operation. If the fever fails to relax the arterial tension so will the operation fail because of occlusive lesions or permanent changes in the arterial wall.

#### REPORT OF CASES

**CASE 1.** A woman aged 34 years a stenographer had arthritis deformans of all joints of the upper and lower extremities of 6 years duration. The condition had resisted all forms of medical treatment. The extremities were cold and clammy, were bathed in sweat, were mottled and cyanotic in appearance and exhibited marked swelling about the joints. Changes ordinarily considered trophic were very marked atrophy of the muscles, thin shiny skin

and ridged thin brittle, and pitted nails. Bilateral lumbar ganglionectomy was performed in June 1926. There was prompt and complete disappearance of all signs and symptoms of arthritis in the lower extremities. At that time we did not advise operation for the condition in the upper extremities since we had not developed the posterior approach to the cervicothoracic ganglia.

The patient was sent home but returned in October 1928 at which time she reported that she had experienced complete cure of the arthritis in her legs. The word cozy she said described her sensations from the waist down during the 2½ years intervening since operation. The legs had been comfortable throughout the whole period with a pleasant sensation of warmth. She had not had pain, tenderness, redness or swelling of the joints concerned although at times she had noticed a little tendency to puffiness of the soft tissues especially about the ankles. In her home town in northern Canada she had walked to and from work throughout the cold winters without at any time experiencing even a suggestion of a recurrence of the arthritis. On the other hand throughout this entire period she had suffered extreme discomfort in all the joints in both upper extremities. The arthritis had relentlessly pursued its disabling and crippling course until she had been reduced to the necessity of doing all her typewriting with one finger. She stated that after the first operation she had gone back to work 3 days after arriving home, had worked steadily for more than a year and then as the result of continuous pain in the joints of the arm had had a nervous breakdown for which she had been sent to California. She had returned to work in February 1928 and had worked every day until she had left for the Clinic. The condition of the shoulder, elbows and hands had been constantly growing worse. She stated that she had not had a good night's sleep in 3 months because of continuous pain in the joints of the upper extremities. This pain always had been present but had undergone acute exacerbations with every storm. The limitation in motion in all the involved joints had become decidedly more marked and there had been some contraction deformity of the ring finger on the right hand at times the joint became locked. Because of the marked progress of the disease in the upper extremities she had returned to the Clinic with considerable joy when the possibility of cervicothoracic sympathetic ganglionectomy had been suggested to her.

The patient was up and around the Clinic and hospital and active on her feet walking everywhere without discomfort. Her weight was 112 pounds (51 kilograms) and the blood pressure 122 systolic and 87 diastolic measured in millimeters of mercury. On general examination it was apparent that changes had taken place in the hands in which the arthritic process had progressed. The hands were now typical of an advanced stage of arthritis deformans. There was considerable swelling of the

metacarpal, phalangeal and interphalangeal joints of the fingers especially of the proximal row and there was atrophy of the intrinsic muscles of the hands. There was beginning ulnar deflection of the hands and fingers. The hands were extremely cold especially the fingers and the palms were continuously wet with perspiration so that the patient was constantly drying them with her handkerchief. A fine film of moisture suggestive of dew almost all ways could be observed over the palms. There was cyanosis from the transverse lines down into the fingers. The hands were cold and clammy. She had no grip in either hand. The fingers felt like useless appendages rather than purposeful or useful organs. The fingers, also imparted a breast-like or lipomatous sensation to the palpating hand. There was a contraction deformity of the ring finger on the right hand. When the hands were raised toward the chin there was considerable ulnar deflection and the fingers dangled. When the patient attempted to raise the hands and spread the fingers there was coarse marked tremor. She was unable to make a firm fist with either hand. In the upper part of the arms there was evidence of loss of subcutaneous tissue and the muscles lacked tonus. She insisted that part of her inability to raise her arms was due to sheer muscular weakness and not to limitation occasioned within the joint. Movement was decidedly limited in the fingers, wrists, elbows, and shoulders and resulted in distinct pain. The skin of the arms seemed atrophic and shiny in appearance.

By contrast the lower extremities were now shapely and firm with abundant subcutaneous tissue. Their appearance did not suggest arthritis in the least. There was no pain on movement. With shoes on the patient could walk on either her heels or her toes. There was bilateral pes planus. Slight grating in the knees and the left ankle remained, however it was not accompanied by pain. The toenails appeared normal, the feet were warm and dry, and the skin was normal in appearance and texture. It was difficult to believe that she had ever had any arthritis in the legs.

In view of the satisfactory results obtained from bilateral lumbar ganglionectomy we felt justified in advising a similar procedure for the upper extremities. Bilateral cervicothoracic ganglionectomy was performed November 23, 1928. At this time the lower cervical and the first and second thoracic sympathetic ganglia along with the intervening trunk on both sides were completely removed through the dorsal mediastinal approach. The operation has been described in previous papers (16, 17, 18).

Immediately following the operation the patient's hands became dry and warm and presented a normal pink color. She noticed immediately that she could make a fist and grip a visitor's hand. She experienced severe burning pain at the operative site over a period of several weeks. This was probably due to operative trauma to the intercostal nerves. Hyperesthesia developed over the inner aspects of

both arms and about the lower and inner aspects of the scapulae. This slowly disappeared. She also complained of a peculiar, continuous pain in the hands and arms which was different from that of arthritis. This was demonstrated to be erythromalgia in character and it cleared up immediately when the arms were raised slightly and supported a little above the level of the body. This also disappeared entirely in the course of from 2 to 3 weeks. Bilateral Horner's syndrome also had developed. There was slight drooping of the eyelids and the pupils were small and did not dilate with cocaine. Neurological examinations showed that no other nervous anomalies could be detected in relation to touch, pain, vibration sense, and stereognosis.

Early after operation the patient had slight arthritic pains occasionally in the upper extremities, so that physical therapeutic measures were instituted but before she had left the hospital she was satisfied that the pains of arthritis had entirely disappeared from all her joints. She was entirely transformed in appearance. The pinched drawn faces and the dark circles under her eyes had disappeared and given place to a happy and contented expression. The strength began to return to the hands immediately following the operation. The swelling rapidly subsided and the tremor of the hands and fingers, which formerly was so evident during attempts at movements of the hands lessened materially. The skin of the hands and arms became dry and slightly suggestive of ichthyosis but this condition soon disappeared.

The sweating mechanism was disturbed. It was anomalous in distribution. Sweat was almost entirely lacking over the extremities and rather marked in quantity over the chest, abdomen and back. With the administration of pilocarpine hydrochloride however sweating could be induced over most of the body.

There was striking elevation of the temperature of the hands. The changes in temperature of the hands following cervicothoracic sympathetic ganglionectomy were almost identical with those observed previously in the feet following lumbar sympathetic ganglionectomy. The increase in the temperature of the feet has been fully sustained over a period of nearly 4 years. The increased temperature in the fingers was accompanied by alteration in capillaries as reflected in those seen in the nailfolds. There the capillaries were easily visualized owing to excellent transparency of the skin. They had sharp margins and a rapid flow of blood without stasis. The collecting venules also, could be clearly visualized.

The patient was dismissed January 7, 1929 to visit some friends and promised to return for re-examination before returning to her home. At this time the symptoms associated with the active arthritis had practically ceased. However she still complained of tenderness and pain between the shoulder blades in the region of the surgical wound. This pain was severe enough at the time of her dismissal to require an occasional dose of codain.



During the patient's visit "sniffles" developed, a condition of moisture of the nasal mucous membranes which has been seen on several occasions following this operation. It proved to be of little if any, consequence. There was also a return of slight pain of an arthritic nature in both wrists and in the right elbow and the shoulder. She could move her arms rather freely, comb her hair, and wash her ears, a privilege that had been denied her for several years. She said that her wrists "locked" occasionally and that some tremor persisted which made her somewhat awkward in the use of her hands.

On the patient's return at the end of March the arms and hands appeared much improved. There was much better muscular tonus in the upper parts of the arms and less wasting of the intrinsic muscles of the hands. The bands and fingers had lost their swelling and were more shapely. The ulnar deflection of the fingers had almost disappeared but it was still noticeable especially when she spread her fingers and raised her arms. Distinct but greatly diminished tremor was also present in the performance of this act. The hands were soft perfectly dry, and very warm. There were no sore places in any joints from the wrists down. The nails (marked with silver nitrate at the margin of the fold at the time of the operation) were more healthy in appearance with less ridging and fewer indentations. The new part of the nail was entirely normal in appearance.

Naturally we were interested in the roentgenographic disclosures but they showed little of interest. The roentgenographic report of the examination of November 15, 1928, stated that there was marked atrophy of the hands with destructive changes in the radiocarpal and carpal joints and various joints of the hands. The final examination, March 18, 1929, showed per arthritic arthritis of the hands and wrists, contraction deformity of the fingers and some atrophy of the right elbow and shoulder joints. The bony changes throughout were extremely slight and the roentgenologist, on comparing the two series, stated that he could not see any essential difference between the first and last series.

At the time of dismissal of the patient, April 9, the general examination did not reveal anything new. The Horner's syndrome persisted but the pupils dilated markedly and promptly when atropine 0.0022 grams (1/30 grain) was administered. She weighed 16 pounds (7 kilograms) more than on the first admission. The blood pressure was entirely normal in all extremities. There was still a slightly painful area over portions of the right scapula. She later reported by letter that she continued to improve and was gradually being relieved of her shoulder pain.

#### COMMENT

The results observed in the case reported here, following sympathetic ganglionectomy, reveal the fact that in certain types of arthritis, the sympathetic nervous system of the extremities is hyperactive, producing

marked vasomotor disturbance and profuse sweating and possibly contributing to the spasm and atrophy of the muscles with the resultant deformities (17, 18).

**CASE 2.** A girl aged 16 years, the daughter of a Greek sheep herder who lives in the mountains of Utah, was well until 26 months before she came to the Clinic. Then, for no known reason, pain appeared in the feet on walking. The pain was intermittent, but never failed to return each day, and became progressively worse. Within the next month her knees also began to ache. About 14 months after the onset her hips became affected similarly and her feet began to swell. Her back had not ached except low in the sacral region. She had not been able to walk a step for 6 months prior to admission, partly because of pain and partly because of weakness in the legs. The pain was worse on motion.

The patient was brought into the Clinic building in a wheel chair. She weighed 89 pounds (40 kilograms) whereas her normal weight had been 114 pounds (51.8 kilograms). Her height was 5 feet 2 inches. She was pale, emaciated, and entirely incapable of walking or standing. The tonsils had been removed previously; small tags remained. Except for a slight systolic apical murmur, examination of the heart gave negative results. The blood pressure in millimeters of mercury was 135 systolic and 80 diastolic when she was examined at the Clinic. Determination of blood pressure taken during her stay in hospital ranged from 118 to 122 systolic and from 68 to 80 diastolic. The pulse rate was 100 beats each minute and the temperature 99 degrees F. There was marked atrophy of the muscles of both legs. Weakness of flexors and extensors of both legs was extreme, but it was more marked in the left leg. The extensors of the ankle were exceedingly weak. Swelling of both feet and both ankles was graded 3 and swelling of the knees was moderate. There was moderate bilateral talipes equinovarus with hallux valgus and spasms of both psoas muscles. Sacral kyphosis was marked and there was rotation of the torso to the right, flexor deformity of the left hip and arthritis affecting the sacro-iliac joints. Reflexes of the ankles and knees were hyperactive. The rigid flat feet could be moved only with the greatest difficulty and they were swollen, cold, clammy, and bathed with perspiration.

The clinical diagnosis was chronic infectious arthritis. Preferably, perhaps, the condition might have been diagnosed as chronic per arthritic arthritis and at the same time the evidence of vasomotor disturbance in the lower extremities might have been emphasized. Evidence of focal infection could not be found in the nasopharynx, sinuses, teeth, or placenta. The small tonsillar tags have been left in place but of course they should be removed later. Roentgenographic examination revealed hypertrophic arthritis of the sacro-iliac joints and lower lumbar

vertebrae. There was some bony atrophy in the right knee. Because of the extreme atrophy and weakness a neurological examination was requested. This examination was considered clinically negative except for atrophy of the muscles and weakness as a result of the patient's stay in bed. The movements of the patient's limbs when sitting or lying were relatively good. On standing however she could not extend her thighs on account of spasm of the muscles, and she was afraid to bear her weight because of pain.

The patient was placed in hospital and physiotherapy was instituted. This has been continued, except for a week or 10 days immediately following operation. On March 30, 1929, both hips were brought down to full extension and Buck's extension applied by an orthopedic surgeon. On April 22, 1929, bilateral lumbar sympathetic ganglionectomy was performed. The second, third, and fourth lumbar sympathetic ganglia, with the intervening trunks were removed from both sides without difficulty. The patient's feet, previously cold and sweaty, were warm and dry when she left the operating table and a good prognosis was given.

Recovery was uneventful. The course throughout has been entirely afebrile. The feet remained warm and dry and devoid of any suggestion of pain. During the first 3 weeks following the operation the patient improved constantly, the swelling disappeared, and she could move her ankles, knees and hips freely, without pain. The extremities were always comfortably warm and dry. She did not experience pain in the feet, ankles, knees, or hips but complained of pain in the muscles of the thighs. This she said was not the same pain she had before the operation but was more like the stiffness and soreness she had experienced at times after playing ball or jumping rope before she was sick. It is a peculiar muscle pain which we have seen in all cases of arthritis when the patient resumes muscular activity.

The patient walked around the bed holding to its sides 3 weeks after the operation. Two or 3 days later she walked with the aid of two canes and after another day or so with one cane. Within 5 weeks after the operation she took a few steps without any assistance whatsoever. Now 6 weeks since operation was performed she can walk unsisted a distance of 100 feet or more without experiencing pain of any kind.

The vasomotor index for the finger before operation was 2.2 and for the toe 5.3. The elimination of heat in the left foot was measured before and after operation. Before the sympathetic ganglionectomy the amount of heat imparted to the water in which the foot was immersed was 0.31 calorie each minute for each square inch of surface of the foot. Following the operation it increased to 2.5 and the foot was still warm when it was removed from the bath at the end of 35 minutes. The surface temperature of the feet before operation ranged from 73 to 77 degrees centigrade. Since the operation,

the temperature has been about 32 degrees centigrade.

The patient, like the patient in Case 1, has made favorable progress. She has shown her ability to walk with two canes then with one cane and finally without assistance. She also has demonstrated the flexibility of her ankles, knees, and hips. The lower extremities are pink, warm, and dry. She claims that her joints are entirely free from pain and have been since the day of the operation. The atrophy and weakness of the muscles, however, still is striking. A report 4 months after the operation stated that she could dance and could walk a distance of two squares (18).

**CASE 3.** A woman, aged 44 years, came to the Clinic November 7, 1928, complaining of painful swollen joints, involving the feet, ankles, knees, fingers, hands, wrists and shoulders, which had begun 11 months previously. She had had dilatation and curettage in December, 1927, following which the symptoms apparently began to develop. There were associated marked weakness and septic fever. The left lower extremity, especially the knee, became involved first and in July, 1928, the right lower extremity also became involved, causing the patient to be bedridden for the 3 months previous to registration. She had had tonsillectomy and extraction of a tooth in September, 1928, after which apparently her hand began to be affected. When the patient was admitted to the Clinic, she had diffuse infectious chronic polyarthritis and was running a septic temperature daily of 1 to 2 degrees F.

On examination the patient was found to be bedridden. The skin over the extremities was pale, soft, flabby, cold and wet, there was marked swelling about the joints without apparent effusion. The feet were somewhat oedematous. The systolic blood pressure was 98 and the diastolic was 80 measured in millimeters of mercury; the pulse rate was 132 and the temperature was 100.2 degrees F. Urinalysis was negative. The haemoglobin was 36 per cent, the erythrocytes numbered 2,570,000, and the leucocytes 4,600. The Wassermann reaction of the blood was negative. Gastric examination showed total acidity of 22, but no free hydrochloric acid. The tonsils had been removed, there were some irregularities in the septum, the ears were normal. Roentgenograms of the extremities did not reveal bony change in the joints, the process apparently was periarticular involvement of the soft tissues. Pelvic examination gave evidence of acute cervicitis with endometritis. In view of the history of infection and the septic temperature it was suggested that steps be taken to remove the foci and consequently orthopedic measures and physiotherapy were instituted. This treatment was carried on for a period of approximately 7½ months. During this period repeated blood transfusions were given and more or less continuous physiotherapy consisting of the application of heat and gentle massage. For a certain period, casts were applied to the lower extremities with the idea of immobilizing the joints, also, zinc chloride

was applied to the cervix and uterine canal all of which afforded little, if any, relief, low grade septic temperature continued.

Because of the vasospastic phenomena vascular studies were carried out with the result that the index was found to be very high and in view of experience in the treatment of polyarthritides of a similar type bilateral cervicothoracic ganglionectomy by the posterior approach was performed May 29 1929 at which time the thoracic trunks were resected and the second first and lower sympathetic ganglia were removed. Immediately after operation the skin over the hands and arms became warm and dry the patient was relieved of pain and the function of the fingers hands and arms began to improve. It was not long before the muscular spasm disappeared and the patient was able to move her elbows and to lift her arms above her head. The progress was more or less phenomenal because the patient had failed to respond to the usual types of treatment and because the fever which had continued until the operation subsided completely within 10 days following ganglionectomy. She was dismissed 44 days after operation to recuperate at home and to return later for lumbar sympathetic ganglionectomy.

#### COMMENT

This patient, like those in Cases 1 and 2, represented a syndrome of chronic polyarthritides of the periarticular type with vasospastic phenomena which failed to respond to the usual medical treatment but which immediately began to show marked improvement following the improved circulation resulting from sympathetic ganglionectomy. The unusual feature in this case was that symptoms followed a history of infection and that a septic temperature continued after the foci were removed. Apparently the temperature was influenced by some local process involving the upper extremities which subsided following the change in circulation. The swelling about the joints had begun to subside gradually and I believe it will slowly disappear, and that a satisfactory recovery will result. Further detail in this case will be reported when the patient returns in 3 or 4 months for operation on the lower extremities.

**CASE 4.** A man aged 26 years registered at the Clinic April 29 1919. His early life had been uneventful except for pneumonia at the ages of 3 and 13 years. In 1917 when the patient was 14 years of age for no known reason acute pain with redness and swelling developed in the left ankle. The condition lasted for a few days and then disappeared but was prone to return after exercise and in bad

weather and was sufficiently serious to interfere with walking. The pain and swelling continued to return at frequent and irregular intervals until 1923 when the right knee became similarly affected, and in 1926 when the right wrist became affected. Following operation on the right knee performed in January 1928 the right ankle left knee and right wrist became acutely involved and the lymph nodes in the groin began to enlarge and to show signs of an acute inflammatory process. The history from 1917 to 1928 was one of recurring attacks of an acute form of arthritis affecting the knees wrists and ankles. Treatment had been very extensive including removal of infected teeth and tonsil baling hot applications intravenous injections of typhoid vaccine intramuscular injections of milk autogenous vaccines prepared from cultures from an inguinal lymph node diet casts and massage all of which did not in any way stem the onward progress of the disease.

The patient was anemic and emaciated. He was lying in bed on his back with both hips and knees in flexion. Pupils reacted normally to light and accommodation. The tonsils had been clearly removed and the teeth showed some caries and dentures. The thorax and abdomen appeared to be normal. The left ankle was swollen and motion was limited, the right ankle appeared to be normal and motion was good. There was much periarticular swelling around the knees which were held at an angle of 115 degrees the right knee was practically fixed and the left showed limited motion. Movement of left hip was definitely limited and it was held in a flexed position the right hip was not affected. The lumbar portion of the spinal column showed lordosis with tenderness but good movement. The right hand showed marked periarticular swelling of the wrist and slight flexion deformity of the right elbow. The hemoglobin was 72 per cent erythrocytes numbered 4 000 000 and leucocytes 5 100. The blood pressures averaged about 90 systolic and 50 diastolic measured in millimeters of mercury. The Wassermann reaction of the blood was negative. Roentgenograms of the teeth showed two partially erupted molars but definite evidence of infection was not found. Roentgenograms revealed a destructive type of arthritis of both hips with atrophy also marked atrophy of the right knee and arthritis with atrophy of bone of both ankles and the right wrist and elbow. Roentgenological examination of the thorax was negative. The vasomotor index of the left great toe was 2.5 of the left second toe 7.1 of the right great toe 5.9 and of the right second toe 6.2.

Inasmuch as the patient had had recurring attacks of arthritis with deformity and atrophic changes in many of the joints for 12 years and had run practically the whole gamut of medical treatment for arthritis without appreciable decrease in the activity of the process it was felt that radical procedures should be carried out as soon as possible. Consequently after a thorough study of the case and a brief period of medical treatment bilateral sym-

thetic ganglionectomy and trunk resection were performed June 3, 1929. Immediately after operation, the feet became warm and dry and they could be moved without pain. Slight pain continued in the knees and hips but this gradually disappeared and on the ninth day the patient was able to be up in a wheel chair although he complained of considerable pain in the muscles of the thighs; however, the pain was different from the former arthritic pain. Recovery was slow because of a slight infection in the wound but on the thirty-sixth day after operation he was able to get on his feet. The joints were not painful, but he complained of pain in the muscles and tendons. Occasionally he experienced arthritic pain in the hips and knees before storms. Ganglionectomy was difficult and prognosis questionable because of the osteoarthritic process which had developed within the hip joints.

#### COMMENT

No doubt this case falls in the group of chronic polyarthritis of the periarticular type but apparently the process had lasted so long and was so severe that destruction and hypertrophic changes had occurred in the hips which may never respond to improved circulation. However, since so many patients are seen who manifest osteoarthritic changes preceded by this vascular phenomenon we felt justified in submitting the patient to surgical procedure for it may prove of value in assisting the end results of arthroplasty because of the improved circulation which has developed following ganglionectomy. Definite conclusions cannot be drawn in this case but as time goes on it will be possible to judge whether or not surgical procedure is indicated in cases of this type.

CASE 5. A woman aged 21 years was admitted to the Clinic July 23, 1928 giving a history of chronic polyarthritis of 4½ years duration. The onset had followed acute abdominal cramps, chills, fever, nausea, generalized pain in all joints and swelling in the left knee. It was thought that she had acute appendicitis but because of some dyspnea the heart was believed to be affected and therefore she was advised not to have appendectomy. The abdominal symptoms soon disappeared but the pain in the knee continued and during the next year other joints were affected. Approximately 3 years before admission tonsillectomy had been performed following which she had a stormy convalescence and had been in bed more or less ever since. She also gave a history of attacks of dyspnea, fainting and stabbing pains over the heart which radiated to the shoulders and arms.

Examination gave evidence that the patient had cystitis, and the previous abdominal pains were attributed to this rather than to the appendix. The patient was bedridden and the hip, knee, and ankle joints were swollen, painful and immobile. She immediately was placed under the usual treatment for infectious arthritis which included massage and heat by various electrical appliances. Examinations of the urine and blood were negative. The Wassermann reaction of the blood was negative. The basal metabolic rate was minus 4, the function of the kidney was normal. A small cervical polyp was found associated with slight cervicitis for which treatment was given. Roentgenograms of the thorax and of the thoracic portion of the spinal column were negative; there was some blurring of the articular margin of both hip joints but otherwise the joints were normal. Electrocardiographic examination revealed sinus tachycardia. Again the patient was placed under the usual treatment for 11 months. At first *brisement forcé* for arthritis of the hips was applied with casts in the hope of straightening the deformity. Physiotherapy was instituted. The cervical polyp was removed. The patient remained more or less an invalid.

Vascular studies were made which gave an index of 4.2 on the right great toe and 3.8 on the left great toe with an index of 2.6 on the right index finger, all of which suggested a vasomotor phenomenon even though the skin was not as moist or as cold as is usual in cases of this type. The arthritic process was more or less limited to the lower extremities, with cessation of activity in the upper extremities. Astasia abasia was unquestionably present, but even with this functional element the patient had been confined to her bed for 3½ years without any apparent improvement, and anything that might offer relief was indicated. Bilateral lumbar sympathectomy and trunk resection was performed June 18, 1929 with astonishing results. The pain in the feet, ankles and knees subsided immediately, the skin became warm and dry, and within 3 months the patient with the aid of additional massage and passive motion was able to move the ankles and toes in full range of motion and could flex the knees to an angle of 45 degrees. At first she was able to walk with assistance; now she is able to walk 50 steps without assistance. There is still considerable limitation of motion in the hip associated with pain so that arthroplasty may be necessary. Time alone can tell the degree of improvement that will be obtained. It is doubtful if as much will be accomplished as in the true periarticular types in the early stages without osteoarthritic changes.

CASE 6. A woman aged 34 years registered at the Clinic June 24, 1929 complaining of chronic polyarthritis of 10 years duration. After an epidemic of influenza she, her mother and a brother had had arthritis; the brother recovered 1 year after the onset, the mother's disease continued until death. The patient's arthritis appeared to increase for 2 or 3 years and then remained stationary for 7

time, again it increased in severity, and continued so for 3 or 4 years previous to her coming to the Clinic. With the arthritis, unconscious attacks developed beginning with chilliness and numbness. Following these attacks she noticed that the extremities were cyanotic and her head ached severely. The last few attacks had been associated with jerking sensations, suggestive of a convulsive seizure.

The patient had bilateral bunions and the toes were deflected laterally under the other toes, with marked callous formation. The ankle joints were swollen and painful, and there was 50 per cent limitation of motion. The right knee was mobile but tender and the left knee was swollen with slight limitation of motion. The hips and spinal column were apparently free from involvement. There was tenderness over the right shoulder, but no limitation of motion, motion of the left shoulder was limited to 75 per cent. There was slight flexion deformity in the left elbow with 15 per cent limitation of motion and some tenderness. The right wrist was in a slightly flexed position and the left wrist motion was limited to 50 per cent. The fingers of the left hand were not deformed, but motion was limited so that they could not be flexed sufficiently to make a fist; the fingers of the right hand had both deformity and fixation. The patient complained mostly of the feet, ankles and knees since they interfered with her activity; she was able to walk in a hobbling sort of fashion but was unable to climb stairs and was constantly troubled with pain and tenderness. The tonsils had been removed. The urine was normal, the blood was normal except for slight anemia, the hemoglobin being 64 per cent, the erythrocytes numbered 3,890,000 and the leucocytes 6,200. The Wassermann reaction of the blood was negative. Roentgenograms of the spinal column were negative. Cultures were made from the cervix and Crum negative bacilli and a few streptococci were found but there was no evidence of cervical erosion or endometritis. The systolic blood pressure was 120 and the diastolic 80 measured in millimeters of mercury. The temperature was 98 degrees F and the pulse rate was 88. There was a history of chronic deafness on the left side, the result of previous infection; a roentgenogram of the left mastoid showed cloudiness. Roentgenogram of the thorax was negative; that of the elbows showed periarticular arthritis; that of the hands destructive arthritis of the phalangeal joints with deformity and calcareous spurs; and that of the lower extremities periarticular arthritis of the ankles and knees. A diagnosis was made of progressive deforming arthritis with destructive changes associated with vasomotor disturbances and an increased vascular index.

Because of the long history and the thorough trial of physiotherapy and orthopedic measures without much improvement the patient was advised to have bilateral sympathetic ganglionectomy with postponement of the operation for the upper extremities. The operation was performed July 23, 1929. The bunion on the right foot and the hammer toe on the

left foot were also operated on. The patient's convalescence was rather stormy because of the development of postoperative ileus but this finally adjusted itself, and recovery was satisfactory. The pain had practically disappeared in the feet, ankles and knees by the time the patient was dismissed from observation which was approximately 8 weeks from the time of operation. She was able to walk much more freely and could walk upstairs which she had not been able to do for several years.

#### COMMENT

Further time must elapse before this patient obtains maximal improvement. An accurate prognosis with regard to results in joints with marked osteoarthritic processes cannot be given, but we are impressed with the fact that if these patients are operated on earlier in the course of the disease, it is likely that the osteoarthritic processes may be forestalled, and, therefore, there is justification for operating in some of these border-line cases.

#### SUMMARY

In summarizing the fundamental factors that produce chronic arthritis, we quote from Bankart's recent article:

"During life the joints are not passive pieces of mechanism but living structures which react to use like other living tissues. Every functional use of a joint is in a sense an injury; that is, friction and pressure tend to wear away the opposed articular surfaces. This normal wear and tear is at once made good by increased blood supply and nutrition which always accompanies function in normal tissues; hence the balance between wear and repair is dependent upon an adequate vascular response to function. If for any reason the vascular response in a joint is deficient so that the process of repair is not equal to the demands made upon it, the joint simply begins to wear out and the cartilage becomes worn away where the friction and pressure are the greatest. But the products of degeneration act as irritants to living tissues, so that in addition to degeneration in the center of the joint there is also irritation, which makes itself evident in hypertrophic changes at the periphery where the blood supply is still abundant.

"Thus the characteristic features of osteoarthritis are degeneration leading to atrophy,

erosion, and eventual disappearance of the cartilage in the center of the joint, and hypertrophy leading to the formation of osteophytis at the periphery."

Bankart's opinions, which are held by many observers, offer a practical explanation of the chronic arthritic process. Thus it is fair to assume that these chronic arthritic processes occurring in young persons with pliable arteries are due to circulatory disturbance of the vasospastic type and that we are justified in performing sympathetic ganglionectomy and trunk resection when the simpler methods fail. It is likewise important that the surgical procedure should be instituted early in the course of the disease, before bony changes have taken place, in order to obtain the maximal result from operation.

#### BIBLIOGRAPHY

1. ADSON A W and BROWN G E The treatment of Raynaud's disease by resection of the upper thoracic and lumbar sympathetic ganglia and trunks Surg. Gynec & Obst 1929 xliii 571-603
2. Idem Raynaud's disease of the upper extremities successful treatment by resection of the sympathetic cervicothoracic and second thoracic ganglia and the intervening trunk J Am M Ass 1929 xcii 444-449
3. BANKART A S B Chordotomy in the treatment of osteo-arthritis of the hip Lancet, 1929 ii 378-380
4. BAYLESS W M Principles of General Physiology, 4th ed p 704 London Longmans Green and Company 1924
5. BRUENING I RITZ Weitere Erfahrungen ueber den Sympathicus Klin Wochenschr 1923 ii 1872-1874
6. DAVIS LOYAL and KANAVEL A B Sympathectomy in Raynaud's disease erythromelalgia and other vascular diseases of the extremities Surg. Gynec & Obst 1926 xlii 729-742
7. DIEZ J El tratamiento de las afecciones tróficas y gangrenosas de los miembros por la resección de las cadenas cervico-torácica y lumbo-sacra del simpático Prensa méd 1923 1926 xi 377-403
8. ELLISON J F Vasomotor and reflex sequelae of unilateral cervical and lumbar ramisection in a case of Raynaud's disease with observations on tonus Ann Surg 1928 lxxviii 827-841
9. HILTZ J Résultats de la sympathectomie péri-artérielle dans le traitement des troubles nerveux post-traumatiques d'ordre réflexe (type Babinski-Froment) Lyon chir 1917 xiv 754-797
10. JAROLLY Quoted by Leriche
11. JOHNSON THOMAS Traitement chirurgical de la lésion de poitrine par la résection du sympathique cervico-thoracique Presse méd 1921 xxxi 193
12. LERICHE RENÉ De l'elongation et de la section des nerfs périsvasculaires dans certains syndromes douloureux d'origine artérielle et dans quelques troubles trophiques Lyon chir 1913 x 3,8-382

13. LERICHE, RENÉ and FONTAINE RENÉ Experimental and clinical contribution to the question on the innervation of the vessels Surg Gynec & Obst 1928 xliii 631-643
14. ORRELL Z A Personal communication
15. RANSON S W Anatomy of the sympathetic nervous system with reference to sympathectomy and ramisection J Am M Ass 1916 lxxxvi 1836-1890
16. ROWNTREE L G and ADSON A W Polyarthritides further studies on the effects of sympathetic ganglionectomy and ramisection J Am M Ass 1929 xcii 170-182
17. Idem Result of bilateral sympathetic ganglionectomy and ramisection for polyarthritides of the lower extremities Proc Staff Meetings Mayo Clinic 1928 iii 333-334
18. Idem Chronic infectious arthritis treated by lumbar sympathetic ganglionectomy and trunk resection report of a case Proc Staff Meetings Mayo Clinic 1929 iv 186-187
19. ROYLE N D The treatment of spastic paralysis by sympathetic ramisection Surg Gynec & Obst 1924 xxxix 701-720
20. Idem The surgical treatment of Raynaud's disease and similar conditions Med J Australia 1927 Suppl ii 341-343
21. Idem Sympathetic trunk section a new operation for Raynaud's disease and spastic paralysis of the upper limb Med J Australia 1928 ii 436-438

#### DISCUSSION

DR LEWIS J POLLOCK Chicago We have seen that in certain carefully selected cases sympathectomy has been followed by a gratifying amelioration of the suffering of patients afflicted with polyarthritides. A few questions present themselves to me:

1. Why has the number of such cases been so small?

2. What are the pathognomonic signs indicating cases suitable for this operative procedure?

3. Does the therapeutic result really mean that this type of polyarthritides is due to the disturbance in circulation or is not the disturbance in circulation due to the arthritides?

Although forgotten by most of our confreres the neurologist still remembers that in 1835 John Hunter first called attention to disproportionate weakness and atrophy of the muscles which occur as the result of some lesions of joints. These early observations were confirmed by a series of studies by Gosselin in 1859 by A. Olivier in 1869 and by L. Fort in 1872 and 1876. In 1872 Volz presented in his inaugural thesis a clinical and experimental study and a detailed history of this reflex nervous disturbance.

Charcot, in 1883, in a study of the atrophies following lesions of the joints showed that the atrophied muscles present a mere diminution of electrical excitability. He showed that there is no necessary relation between the intensity of the joint affections and that of the paralysis and atrophy. Months may elapse with the limb still useless, whereas the arthritis has for a long time only been manifested by a slight thickening of the peri-articular tissues if

time, again it increased in severity, and continued so for 3 or 4 years previous to her coming to the Clinic. With the arthritis unconscious attacks developed beginning with chilliness and numbness. Following these attacks she noticed that the extremities were cyanotic and her head ached severely. The last few attacks had been associated with jerking sensations suggestive of a convulsive seizure.

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#### BIBLIOGRAPHY

- ADSON A W and BROWN G E The treatment of Raynaud's disease by resection of the upper thoracic and lumbar sympathetic ganglia and trunks Surg. Gynec & Obst 1929 xlviii 577-603
- Idem. Raynaud's disease of the upper extremities successful treatment by resection of the sympathetic cervicothoracic and second thoracic ganglia and the intervening trunk J Am M Ass 1929 xcii 444-449
- BANKART A S B Chordotomy in the treatment of osteo arthritis of the hip Lancet 1929 ii 378-380
- BALLIS W M Principles of General Physiology 4th ed p 704 London Longmans Green and Company 1924
- BRUNTO F RITZ Weitere Erfahrungen ueber den Sympathicus Klin Wchnschr 1923 ii 1872-1874
- DAVIS LOYAL and KANAVEL A B Sympathectomy in Raynaud's disease erythromelalgia and other vascular diseases of the extremities Surg. Gynec & Obst 1926 xlii 729-742
- DIEZ J El tratamiento de las afecciones tróficas y gangrenosas de los miembros por la resección de las cadenas cervico-torácica y lumbo-sacra del simpático Prensa méd 1925 1926 xii 377-403
- FULTON J F Vasomotor and reflex sequelae of unilateral cervical and lumbar ramisection in a case of Raynaud's disease with observations on tonus Ann Surg 1918 lxxviii 877-841
- HEITZ J Résultats de la sympathectomie périaortale dans le traitement des troubles nerveux post-traumatiques d'ordre réflexe (type Babinski-Froment) Lyon chir 1917 xiv 754-797
- JABOULAY Quoted by Leriche
- JONVESCO THOMAS Traitement chirurgical de l'angine de poitrine par la résection du sympathique cervico-thoracique Presse méd 1921 xxx 193
- LERICHE RENÉ De l'élongation et de la section des nerfs périsvasculaires dans certains syndromes douloureux d'origine artérielle et dans quelques troubles trophiques Lyon chir 1913 x 378-382

- LERICHE RENÉ and FONTAINE RENÉ Experimental and clinical contribution to the question on the innervation of the vessels Surg, Gynec & Obst 1928, xlvii 631-643
- ORRELL Z A Personal communication
- RANSON S W Anatomy of the sympathetic nervous system with reference to sympathectomy and ramisection J Am M Ass 1926 lxxvi 1896-1899
- ROWNTREE L G and ADSON A W Polyarthritides, further studies on the effects of sympathetic ganglionectomy and ramisection J Am M Ass 1929 xciii 170-182
- Idem Result of bilateral sympathetic ganglionectomy and ramisection for polyarthritides of the lower extremities Proc Staff Meetings Mayo Clinic 1928 ii 333-334
- Idem Chronic infectious arthritis treated by lumbar sympathetic ganglionectomy and trunk resection, report of a case Proc Staff Meetings Mayo Clinic 1929 ix 186-187
- ROYLE N D The treatment of spastic paralysis by sympathetic ramisection Surg. Gynec & Obst 1924 xxxix 701-720
- Idem The surgical treatment of Raynaud's disease and similar conditions Med J Australia 1927 Suppl ii 341-343
- Idem Sympathetic trunk section a new operation for Raynaud's disease and spastic paralysis of the upper limb Med J Australia 1928 ii 436-438

#### DISCUSSION

DR LEWIS J POLLOCK Chicago We have seen that in certain carefully selected cases sympathectomy has been followed by a gratifying amelioration of the suffering of patients afflicted with polyarthritides. A few questions present themselves to me:

1 Why has the number of such cases been so small?

2 What are the pathognomonic signs indicating cases suitable for this operative procedure?

3 Does the therapeutic result really mean that this type of polyarthritides is due to the disturbance in circulation, or is not the disturbance in circulation due to the arthritides?

Although forgotten by most of our confreres, the neurologist still remembers that in 1835 John Hunter first called attention to disproportionate weakness and atrophy of the muscles which occur as the result of some lesions of joints. These early observations were confirmed by a series of studies by Goesslin in 1859 by A. Ollivier in 1869, and by L. Fort in 1872 and 1876. In 1872 Volz presented in his inaugural thesis a clinical and experimental study and a detailed history of this reflex nervous disturbance.

Charcot in 1883 in a study of the atrophies following lesions of the joints showed that the atrophied muscles present a mere diminution of electrical excitability. He showed that there is no necessary relation between the intensity of the joint affections and that of the paralysis and atrophy.

Months may elapse with the limb still useless whereas the arthritides has for a long time only been manifested by a slight thickening of the periarticular tissues if



indeed there be even as much as that left. Not only was this atrophy and weakness of muscles noted but Vulpian in 1886, emphasized the neuralgias and pain, the trophic disturbances of the skin hair and nails, the secretory disorders such as sweat the coldness of the limb and the cyanotic or dull pink color of the skin. One of the reasons that this has been forgotten is that such changes do not occur in all cases of polyarthritis but only in a very small number of them. Vulpian likewise found that all peripheral lesions including frost bite burns and more or less deep wounds of the limbs may become a starting point of such phenomena. Such disturbances therefore to use Dutil's expression may have an articular or abarticular origin.

In the late war the distinguished French neurologists Babinski and Froment described a group of cases under the name of physiopathic reflex nervous disturbances. These cases presented contractures and paretic states which occurred after traumatic far removed from important nerve trunks. The lesions which produced them were very slight and out of proportion to the resulting disturbance of function. They differentiated these cases from hysteria by various symptoms which included muscular atrophy, hyperexcitability of the muscles, hypothermia, loss of vasomotor control (cyanosis, salmon pink tint), diminution in the amplitude of vascular oscillations at the periphery of a limb, secretory disturbances and lastly trophic disorders of the bones skin hair and nails. These disorders were included by Babinski and Froment in the nosological group originated by Hunter occurring at times as the result of polyarthritis at other times as the result of peripheral lesions. Although the pathogeny of these conditions was the subject of considerable controversy at a special meeting of the Paris Neurological Society in 1916 it was concluded that nervous disorders exist quite distinct from hysteria and which are associated with real physiological disturbances of which the mechanism is still a matter of discussion which may be grouped with the reflex disorders observed after osteoarthritis lesions.

The meaning which Charcot and Vulpian gave to the term reflex may be gathered from the following. The favorite theory says Charcot with most contemporary writers appears to be this. The articular affections reflect certain irritant impulses along the articular nerves to the spinal cord which impulses modify the trophic centers in that organ whence emanate the motor nerves which regulate the nutrition of the muscles.

But can we explain by a reflex action all the phenomena which form part of the syndrome under discussion and especially the vasomotor and thermal disorders? Babinski and Froment had long been impressed with the importance of the vasomotor and thermal disorders in these conditions which they felt indicated a disturbance of the sympathetic nervous system. A reflex pathogeny appears to them to explain all the peculiarities of the syndrome.

Among the symptoms which constituted it some such as vascular spasm are the direct result of a reflex action while others such as the hyperexcitability of the muscles and slowness of the contraction appear as an indirect result of the vasomotor and thermal disturbances. It is possible that the motor disturbances may depend either as Charcot had supposed on the state of the spinal motor centers or on disturbances due to sympathetic vasomotor phenomena which are themselves of reflex origin. Not only do Babinski and Froment find no need to oppose the reflex pathogeny to the sympathetic pathogeny but they point out that they harmonize with one another very well the vasoconstriction being the result of a reflex action exercised through the sympathetic system. The symptoms of a reflex character result therefore from a peripheral lesion which causes disturbance in the spinal centers and in the sympathetic system simultaneously.

It is interesting to find in the description of these cases just such observations as Dr Adson has noticed in relation to his cases of polyarthritis. The affected hand or foot is cyanosed mottled or a uniform salmon red tint the slightest pressure causes a local ischemia and the white spot thus produced is slow in disappearing. Hypothermia definitely perceptible to the touch and sometimes very pronounced is associated with the vasomotor disorders. The difference in temperature between the affected limb and the sound limb is as much as 8 degrees C. marked erythema. The microphygmia and diminished red cells the damp skin which at times is macerated at times beaded with sweat the general atrophy the trophic changes in the nails all strikingly resemble the phenomena occurring in the cases benefited by sympathectomy. Babinski and Froment found that progressive improvement followed thermotherapy and Leriche performed a periaxillary sympathectomy upon 3 such cases all of which showed distinct improvement.

It would appear to me therefore that the type of polyarthritis which Dr Adson has found may be successfully treated by sympathectomy is the type which exhibits symptoms corresponding to those described by Hunter Charcot and Vulpian as reflex disorders due to articular lesions and by Babinski and Froment as due to abarticular ones. In both instances the reflex disturbances of vasomotor and secretory character are mediated through the sympathetic nervous system and the sympathectomy is followed by an amelioration of all of the symptoms due to this reflex disturbance. The pathological state of the joint itself as pointed out by Charcot may in contrast be slight indeed.

This seems to me to be more logical than to attribute to the vascular change the function of the pathogeny of the arthritis inasmuch as Dr Adson himself in describing some of these cases called one an infective polyarthritis and another an arthritis deformans. The small number of suitable cases can then be more readily understood. The fact that exactly similar conditions occur when the joints are

not involved, and do not become involved after many months of persistent vasomotor and thermal change bears out this opinion

DR S W RANSON, Chicago The nerve impulses responsible for vasoconstriction in the leg leave the spinal cord along preganglionic fibers in the lower thoracic and upper lumbar spinal nerves These fibers reach the sympathetic trunk through the white rami and end in the lumbar and sacral sympathetic ganglia whence the impulses are relayed by postganglionic fibers in the gray rami to the nerves forming the lumbosacral plexus and thence to the blood vessels in the leg Removal of the second third and fourth lumbar sympathetic ganglia absolutely blocks the vasoconstrictor impulses to the leg In the same way the removal of the inferior cervical and first two thoracic ganglia completely blocks the vasoconstrictor pathways to the arm

If it is true that there is a vasospastic type of chronic arthritis ganglionectomy and trunk resection as practiced by Dr Adson are the logical methods of treatment The real question is a clinical one Is there such a type of arthritis? and this is one with which I am not competent to deal

But we may ask whether the vasodilation that results from severing the vasoconstrictor paths may not by increasing the flow of blood even above normal favorably influence various pathological conditions of the extremities which are not directly due to vascular spasm This would depend largely on the length of time that the vessels remained dilated

It is generally believed by physiologists that the vasodilation which results from section of the vasoconstrictor fibers is temporary and that the blood vessels quickly acquire a tone of their own quite independent of the nervous system As an illustration let me quote from a paper by Dr Tower in the *American Journal of Physiology* for 1926 The paper states that the left stellate ganglion had been removed in dogs 'Immediately following the operation the blood vessels of the fore leg neck and head were dilated on the side of the lesion The whole leg felt hot and the paw pads if lightly pigmented, appeared flushed as compared with the pallor of the normal paw This condition persisted a very short time In several days the vessels had regained tone appreciably and after 10 days or 2 weeks there was usually no detectable difference in temperature or color between the two fore paws while the animal was quiet From this time on the blood flow through the two fore limbs as judged from paw temperature and color was equal during rest but in prolonged activity or in any condition attended by reflex vasodilation it was greater in the normal limb while con-

versely in conditions attended by reflex vasoconstriction in this limb it was less'

These observations support the opinion generally held today that after sympathectomy the dilated blood vessels quickly regain their normal size, though they no longer take part in vasoconstrictions or vasodilations of nervous origin There is no evidence, however, that these observations of Dr Tower which were purely incidental and not the main object of the investigation were made with great care nor is the method of measuring the temperature recorded This criticism holds for all the experimental work on this subject with which I am familiar The skin temperatures have not been accurately measured with the thermocouple and the rate of heat elimination has not been determined in calories

Moreover there is some experimental work on record that supports the idea that the circulation may be speeded up for a long time after sympathectomy Dale and Richards found that in the denervated limb of the cat tone quickly returned to the capillaries while the arterioles remained dilated throughout the 2 months that the animals were kept under observation Because of the constricted capillaries the skin was pale but because of the dilated arterioles, the circulation was rapid the skin temperature high, and the heat elimination great

If it should prove to be true that the arterioles remain dilated for many months and the circulation is correspondingly speeded up in a sympathectomized limb it would be reasonable to look for benefit from sympathectomy in any condition that would respond favorably to an increased circulation Further studies are needed and these should be conducted with the same careful measurements of skin temperature and rate of blood flow which Dr Adson and his associates have used in The Mayo Clinic

The question arises, How vital a rôle does the sympathetic system play and are we ever justified in tampering with it? Dr Cannon and his students have answered this question by completely removing the sympathetic chain on both sides from the highest cervical to the lowest sacral ganglion Such completely sympathectomized cats have lived under laboratory conditions for many months Doubtless such animals would succumb in the struggle for existence in the open where they had to fight for a living and adapt themselves to wide variations in temperature But in the favorable conditions of the laboratory they lived an apparently normal existence Everything indicates that almost any part of the sympathetic system can be removed without seriously endangering life

CHONDROSARCOMA OF BONE<sup>1</sup>

D B PHEMISTER MD FACS CHICAGO

From the Department of Surgery of the University of Chicago

**T**HIS study is limited to a consideration of a certain group of bone tumors containing cartilage with a view to having them recognized as a separate class. In the existing classification of the Registry of Bone Sarcoma of the American College of Surgeons, four types of lesions are recognized: one, osteogenic sarcoma with five divisions, two, periosteal fibrosarcoma, three, myeloma, which is subdivided into multiple myeloma and endothelial myeloma, or Ewing's tumor, and four, giant cell tumor undergoing malignant degeneration. There are many objections to this classification. One of the most valid is that the term osteogenic sarcoma is used too broadly at present, being indicative of all malignant tumors derived from bone or from tissue destined to form bone. It includes groups of tumors that differ as widely from each other as they do from the other classes. This is particularly true of certain sarcomata containing cartilage, and still they are thrown in the general group of osteogenic sarcomata without even being dignified as a subdivision. It is admittedly hard to classify tumors containing cartilage, but since benign cartilaginous tumors or chondromata of bone are quite generally recognized, it would seem equally feasible to recognize a class of malignant cartilaginous tumors. If tumors are classified according to tissue type, we then have the possibility of chondrosarcoma as well as chondroma developing in all bones that are performed in cartilage. Chondrosarcomata have long been recognized as a class in the European literature and are still so recognized by many American pathologists.

Cartilage may be seen in the extracortical portions of osteogenic sarcomata which ossify by the enchondral method passing through the fibrous, cartilaginous, and osseous stages just as does the peripheral callus of a fracture in its metamorphosis from soft tissue into bone. On the other hand cartilage may comprise the bulk of the sarcoma situated either centrally or peripherally and appear as the

chief end product of tumor differentiation. Tumor bone may also be present which may be formed either by the enchondral method or by both enchondral and fibrous methods. When this is the case the term chondro-osteosarcoma has been used by Ribbert, and, when myxomatous tissue is present, myxochondro-osteosarcoma. It is extremely difficult to know in such cases whether or not part or all of the tumor comes from chondrogenic tissue. Regardless of this fact it is better in general to designate sarcomata consisting largely of cartilage as chondrosarcomata and those containing tumor bone with cartilage either absent or present only in small amounts in the regions of ossification as osteogenic sarcomata. A central sarcoma containing cartilage is more suggestive of chondrosarcoma than a peripheral one because proliferating bone of central origin as the endosteal callus of a fracture does not have cartilage appear in the process of ossification while that of peripheral origin has it as a rule.

Chondrosarcomata present sufficiently distinct morphological, clinical and roentgenological characteristics to warrant their designation as a separate entity. They consist largely of islands of hyaline cartilage which, in the growing regions may shade over into round cell precartilaginous showing karyokinetic figures, hyperchromatic nuclei and other microscopic evidences of malignancy. However, in many cases the cartilage is of a mature type and the microscopic evidences of malignancy are either scanty or absent. Older portions of the tumor often calcify and ossify. The calcification and ossification frequently occur in islands and branching clumps irregularly distributed throughout the tumor. They produce irregular blotchy shadows in roentgenograms which are quite characteristic for chondrosarcoma making it often possible to recognize the condition preoperatively. On the whole, chondrosarcomata grow more rapidly than osteogenic sarcomata and give rise to metastases at a later date. From the cases herein

<sup>1</sup> Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 24-28, 1939.



Fig 2 Photograph of specimen shown in Figure 1

Fig 1 Central chondrosarcoma with blotchy areas of increased density in upper portion from calcification and ossification. No peripheral new bone formation except at lower part of tumor

reported it would seem that the prognosis is somewhat better than that of osteogenic sarcoma. Ernst, Simon, and Schmaus Herxheimer have claimed that chondrosarcomata possess a special tendency to invade the veins resulting in a thrombus which may extend for a great distance and even reach the heart. There is one such case to be reported in this group. The metastases in other organs are also cartilaginous and become partly ossified or calcified. Some of the chondrosarcomata arise from chondromata and cartilaginous exostoses of bone. However, sarcomata originating in a cartilaginous exostosis may take on another form, as fibrosarcoma or myxosarcoma.

In a series of 61 bone sarcomata which I have studied pathologically in the laboratories of the surgical clinics of the University of Chicago there have been 10 cases that have been classified as chondrosarcoma. They were distributed as follows: femur, 3

humerus 2, tibia 2, maxilla, 1, spine, 1, rib 1. In studying the cases of the registry it has not been uncommon to find histological and roentgenological evidence of cartilage in tumors listed under the heading of osteogenic sarcoma and a review of the material even in the absence of the gross specimen shows that some of them belong in the group of chondrosarcomata.

Chondrosarcomata of long bones may arise either centrally or peripherally. They are nearly always located in the ends of the shaft beginning some distance away from the epiphyseal line. Central chondrosarcomata erode the cancellous bone and cortex within producing an expansile swelling of the shaft. In some cases this is unaccompanied by new bone formation on the periosteal surface, while in others there is marked periosteal new bone formation leading to a thick shell about the central tumor which casts a characteristic shadow in the X-ray. The following is a case of central chondrosarcoma eroding the shaft without stimulating new bone formation.

J A Bone Sarcoma Registry No 812 surgeon Dr Gatewood. Male colored aged 29 entered the

CHONDROSARCOMA OF BONE<sup>1</sup>

D B PHEMISTER M D, F A C S, CHICAGO

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<sup>1</sup>Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 14-18, 1929.



Fig 5 Coronal section of specimen shown in Figure 4 with hyaline cartilage interior

of round cell precartilage about the periphery of the tumor in certain regions showing evidence of marked tumor growth. Very few karyokinetic figures or heavily staining nuclei were to be seen. Diagnosis chondrosarcoma. Three and one half years after amputation the patient was alive and well.

There are two cases of chondrosarcoma of the upper end of the femur which began centrally and stimulated marked surrounding new bone formation. They eventually broke through the cortex to form a tumor about the periphery of the bone.

L. B. Bone Sarcoma Registry No 1025 surgeon Dr Kellogg Speed. Male aged 41 years entered the Presbyterian Hospital October 2 1921. He had pain in the upper end of the left thigh for about one year and for 4 months had had a swelling of the upper end of the left femur most marked over the dorsum. There had been no loss in weight and his general health had not been affected. Examination



Fig 6 Histological appearance of centrally situated cartilage shown in Figure 5

revealed a well developed colored male. Physical examination was negative aside from the region of the left thigh. There was a moderate sized swelling of the upper third of the shaft of the femur which was most marked on the posterior side. It was firm and not tender. There was slight limitation in motion of the hip. A roentgenogram (Fig 4) revealed a centrally situated oblong area of reduced density of the upper end of the femur extending downward from the base of the neck for a distance of 10 centimeters. The cortex about it was expanded into a spindle shaped swelling and was markedly thickened. The shaft was also slightly expanded and showed an increase in density for a distance of 4 centimeters below the limits of central destructive area. A diagnosis was made of sarcoma of the femur and the hip joint was disarticulated. Dissection of the specimen revealed a spindle shaped swelling of the upper 6 inches of the shaft of the femur which was most marked in its posterior and superior portions. The swelling was bony and hard anteriorly but posteriorly there was an egg sized area of soft semi fluctuant tissue. When this was cut into it was found to consist of bluish hyaline cartilage with extensive mucoid degeneration in its central portion. Longitudinal section of the bone revealed a large ovoid mass of bluish soft cartilage filling the slightly expanded medullary cavity of the upper 10 centimeters of the shaft (Fig 5). The cortex was perforated posteriorly where the hyaline cartilage tissues on the inside and outside of the bone were in communication. The surrounding cortex showed marked thickening varying in width from 0.8 to 2 centimeters. There was also marked bony thickening of the shaft for 4 centimeters below the cartilaginous tumor. Microscopic examination showed



Fig 3 Section of cartilage from interior of Figure 2  
a Growing zone b calcified cartilage



Fig 4 Central chondrosarcoma with thick shell of new bone surrounding it

Presbyterian Hospital March 7 1926 One and a half years previously he injured the left shoulder while wrestling following which there was slight limitation in motion but no pain About a year later he again injured it by throwing since which time he has had pain in the shoulder at times and swelling has gradually developed in the region of the upper end of the humerus It has grown rapidly in the last 4 months and there has been increase in pain and disability There has been no loss in weight and the patient's health has otherwise been good Examination reveals a well developed colored male with negative findings except in the region of the left shoulder There is a marked swelling of the upper half of the humerus which is firm and free from tenderness There is moderate limitation of motion in the shoulder Roentgenograms (Fig 1) of the left humerus show a large heart shaped swelling of the upper half of the bone with the base at the shoulder joint Bony cortex has been completely eroded in this region the erosion ending eccentrically downward in the shaft Scattered irregularly throughout the upper part of this large soft parts shadow which replaces the bone are blotchy areas of increased density indicative of zones of calcification or ossification X rays of the chest were negative for metastases Diagnosis chondrosarcoma of the humerus based on the irregularly distributed areas of increased density seen in the X ray A chest girdle amputation of the extremity was performed Dissection of the specimen (Fig 2) revealed a heart shaped tumor of the upper half of the humerus which had completely

replaced the bone It was apparently limited by the expanded rests of periosteum It measured 8 1/2 inches in length and 4 1/2 inches at its greatest diameter The surface of the tumor was somewhat nodular on longitudinal section It was found to be bluish in color in most places looking like hyaline cartilage Scattered throughout the bluish cartilage were irregular yellowish to dark hard areas of calcification and ossification These were most marked in the upper portion of the tumor There was extensive necrosis in the central region with the formation of a cavity The neighboring periosteum and endosteum showed no evidences of reactive new bone formation and there was but slight evidence of calcification or ossification in the peripheral portions of the tumor Microscopic examination revealed a tumor made up very largely of hyaline cartilage (Fig 3) The cells varied greatly in size The matrix was hyaline and in places showed signs of degeneration In the deeper portions of the tumor there were a few small areas of calcified cartilage and trabeculae of bone of immature type There were layers



Fig 9 Junction of central tumor of hyaline cartilage *a* and bony shell infiltrated by round cell tumor *b*



Fig 10 Ossified tumor infiltrating cancellous bone of head of tumor

shaft of the femur. The shadow of the cortex about it is markedly expanded and increased in density and there is thickening of the shadow of the cortex of the shaft below for a distance of 7 centimeters. There is an oval soft parts shadow about the femur at this level but there are no evidences of calcification or ossification in it. Profiting from the study of the previous case a diagnosis of central chondrosarcoma was made. A hip joint disarticulation was performed. Dissection of the thigh revealed a large soft irregularly spherical swelling encircling the upper 6 inches of the shaft of the femur except on its mesial side. In some places fluctuation could be made out. The shaft of the bone was slightly thickened for a distance of 5 centimeters below the soft parts tumor. Longitudinal section of the bone (Fig 9) reveals a sharply circumscribed oval area measuring 12 centimeters in length by 4 centimeters in its greatest diameter occupying the interior of the upper part of the shaft. It is filled largely with bluish cartilage throughout which are scattered yellowish to brown areas of bony density. The bony cortex about this cartilaginous mass is expanded thickened and invaded by tumor. The cortex below is markedly thickened for a distance of 10 centimeters the thickening tapering off from above downward. The medullary cavity below is filled with new bone for a distance of 5 centimeters. The entire head and neck and most of the greater trochanter above the limits of the central cartilaginous tumor are infiltrated with spongy tumor bone. The large spherical swelling located about the periphery of the shaft is composed of bluish hyaline cartilage which has undergone extensive degeneration in its central portion where there are irregular cavities filled with

a mucoid material. Sections were taken from the central and peripheral cartilaginous portions from the sclerosed shell and from the sclerosed bone above and below. Sections of the interior portion consist largely of atypical immature hyaline cartilage which is arranged in large whorls and in places is broken down. It shades over gradually into a round celled tissue which is present in islands within the cartilaginous substance and which invades the bony shell at the periphery (Fig 9). The irregularly dense islands within the central cartilage are composed of calcified cartilage and of immature cancellous tumor bone. Karyokinesis and hyperchromatism can be seen in the round cell tissue. Sections of the bony shell reveal a dense bone which is very extensively infiltrated with round cell tumor there being very little cartilage found. The sections of the thickened bone below and of the head show infiltration with round cell tumor which has undergone extensive ossification forming a very immature type of tumor bone (Fig 10). Sections of the large peripheral tumor show it to be composed of hyaline cartilage which in places about the periphery is richly cellular and actively growing. In other places it shades over into fibrous tissue and in its deeper portions it has undergone extensive degeneration. There are cavities filled with mucoid debris. Diagnosis central chondrosarcoma with marked reactive hyperplasia of the surrounding bone ossification of the tumor infiltrating bone, and mucoid degeneration of the peripheral tumor. The patient made an uneventful recovery from the operation. Six weeks later he began to have headaches which were followed in 2 weeks by paralysis of the right side of the body. A diagnosis of cerebral metastases



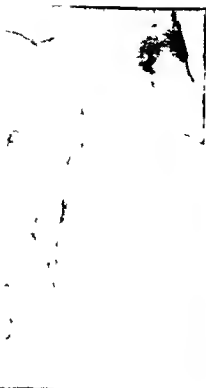


Fig. 7 Central chondrosarcoma with shell of new bone about it

the central tumor to be composed of hyaline cartilage which was somewhat lobulated and contained numerous blood vessels in the interlobular septa (Fig 6). There was actively growing cartilage along the septa of the lobules. The cartilage of the external swelling revealed extensive mucoid degeneration. A section of the bony wall showed markedly irregular new bone formation. There was no evidence of tumor invasion except about the inner limits where cartilage cells are eroding and in places penetrating the vascular spaces of the bone. There were a few small islands of calcification and ossification within the central cartilaginous tumor but none in the tumor outside of the bone. From the rapidity of growth and the gross and microscopic features of the tumor a diagnosis of chondrosarcoma was made. The patient is alive and well now 9 years after operation.

A second case is similar but more malignant and came under observation when the disease was in a much more advanced stage.

S. G., Bone Sarcoma Registry No. 106, male, age 55, entered the University of Chicago Clinics December 10, 1928. He gave a history of pain in the upper part of the left thigh beginning one and a half years before. He was treated for sciatica for several



Fig. 8 Coronal section of specimen shown in Figure 7. Central tumor largely cartilaginous. Bone extensively infiltrated with tumor. Lateral peripheral tumor cartilaginous and markedly degenerated.

months but the pain increased in severity and he lost in weight and strength. Four months ago he noticed a swelling of the upper part of the left thigh which rapidly increased in size up to the time of admission. He received deep X-ray therapy 1 month before admission and had a burn of the skin over the lateral surface. His weight dropped from 225 to 145 pounds in the previous 15 months. Examination revealed a somewhat emaciated elderly man. Regional examination was negative aside from the left thigh where there was a large firm tumor encircling the bone but greatest on the lateral and posterior sides. X-ray examination of the lungs was negative for metastases. A roentgenogram (Fig 7) revealed an oblong central area of irregularly reduced density in the upper 13 centimeters of the

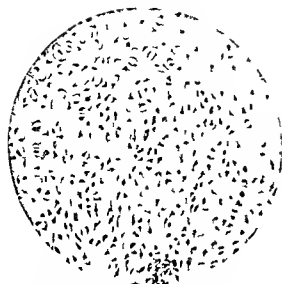


Fig. 13 Photomicrograph of section from periphery of central tumor showing richly cellular hyaline cartilage formation



Fig. 14 Round and spindle cell tumor about the periosteal surface of the bone and infiltrating remnants of cortex

cavity was swabbed with 95 per cent carbolic followed by alcohol and was allowed to fill with blood. The soft parts were closed and a cast applied. Microscopic examination of the excised tissue showed the great mass of the central tumor to consist of mature hyaline cartilage (Fig. 12). The amount of calcification in it was small but it contained a moderate amount of spongy tumor bone, the cancellous spaces of which were filled with a sparsely cellular fibrous marrow. Sections of the tissue about the periphery showed a richly cellular hyaline cartilage (Fig. 13). Sections of the bony cortex showed it to be infiltrated and eroded by a richly cellular round and spindle cell tumor which contained many mitotic figures. The grayish tumor along the periosteal surface presented the same histologic appearance (Fig. 14). A Mallory stain showed almost complete absence of collagen in this growing portion of the tumor. Diagnosis: chondrosarcoma consisting very largely of hyaline cartilage but with a precartilaginous proliferating zone about the periphery and calcified and ossified nodules in the older portions of the lesion. The long duration of symptoms and the absence of evidences of metastases were indications of a relatively benign tumor. Roentgen ray treatments have been started.

The following is a case of chondrosarcoma of the greater tubercle and surgical neck of the humerus which stimulated marked new bone formation on the central side of the lesion.

C. S. Bone Sarcoma Registry No. 7031, male aged 22 years entered the Presbyterian Hospital August 1, 1919. Three and a half years before admission he

began to have slight pains in the region of the right shoulder. This was followed by slight limitation of motion. Recurring pains and stiffness continued up to 2 years ago when an area of reduced density in the region of the greater trochanter was curetted elsewhere. The symptoms recurred and one year ago a second curettage was performed. The nature of the curettages was not learned. The stiffness continued and the pain soon returned. Of late the pain and stiffness have been more marked than ever. He was otherwise in good health. Physical examination revealed a well developed young man with essentially negative findings aside from the region of the right shoulder. There was a scar over the anterolateral aspect of the deltoid and a slight swelling in the region of the greater trochanter which on palpation was hard but not tender. There was marked limitation of motion in the shoulder joint. A roentgenogram of the shoulder (Fig. 15) revealed irregular reduction in density in the region of the greater tubercle and lateral portion of the surgical neck with slight peripheral enlargement. There was marked increase in density of the neck and shaft mesial to and below the region of the tubercle. The density gradually diminishing from above downward for a distance of 2 inches. There was irregularity of the articular surfaces of the shoulder joint indicative of a chronic arthritis. Because of the recurrences after curettage with peripheral extension of the tumor, the marked sclerosis of the surrounding bone and the marked increase in pain, a diagnosis of sarcoma of the humerus was made type undetermined. The upper 6 inches of the humerus including the periosteum was resected, care being taken to go wide of the bone at its upper end. A bone



Fig. 11 Sharply circumscribed erosive lesion of interior with dense pecks at central portion. Thickening of mesial portion of the shell and cortex of shaft.

was made and death followed 3 months after the operation. An autopsy was not performed.

The central eroding portion of this tumor and the large external mass remained largely cartilaginous, but much of the round cell portion infiltrating the bone ossified without the appearance of cartilage in the process. Because of the mixed character of the tissue it might be designated by some as a chondro-osteosarcoma and by others as an osteogenic sarcoma with bone formation by the enchondral method. Since the oldest part and by far the greater part of it remained cartilaginous it would seem more appropriate to call the tumor a chondrosarcoma.

A third case of chondrosarcoma of the upper end of the shaft of the femur has recently come to our attention. In this case the growth produced central cortical erosion and very little peripheral cortical proliferation of bone at the level of the lesion. However, there was considerable proliferation along the course of the shaft below.

E. K., female, aged 39 years, entered the University of Chicago Clinics with a history that for 6



Fig. 12 Mature hyaline cartilage from central portion of tumor.

years she had had pain of varying intensity in the sole of the foot and outer side of the leg and thigh. It had been more severe in the hip for weeks. As a result of slight violence it suddenly became worse and she was unable to walk. A roentgenogram taken immediately showed a sharply circumscribed central destructive lesion of the upper end of the femur extending upward into the trochanters and base of the neck (Fig. 11). The surrounding cortical shell was thickened mesially and there was a transverse fracture line at the middle of its thin lateral portion. The shaft below presented evidence of periosteal thickening on the mesial side extending downward for 5 centimeters and was more dense in the endosteal region for a distance of centimeters below the eroding area. At the center of the area of reduced density there were a few dense specks suggestive of calcified or ossified areas. The one along with the periosteal thickening of the shaft aroused suspicions of a central chondrosarcoma. The patient showed no general evidence of malignancy and roentgenograms of the chest were negative. Benign giant cell tumor was also considered but this is an unusual location for such tumors. Bone cyst was also thought of but a solitary cyst beginning in adult life is a rare occurrence.

At operation a thin layer of grayish soft tumor was found breaking through the cortex laterally. A window of cortex 3 inches long was excised. The bone was found to be eroded and infiltrated with tumor. The large central cavity was filled with soft tumor which was bluish gray in its peripheral portion but beneath the surface it consisted of a firm bluish hyaline cartilage which in places contained islands of calcification and ossification. The tumor was curetted out as thoroughly as possible. The

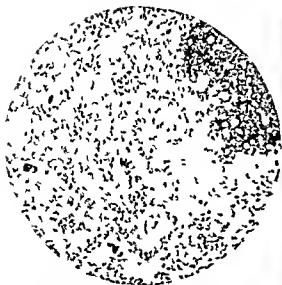


Fig 18 Histological section of tumor shown in Figure 16 with island of calcified cartilage *a* and giant cells scattered throughout the hyaline cartilage

tumor. The submaxillary and deep lymph glands were also excised on the affected side. The patient returned 16 months later with a recurrence considerably larger than the original tumor. At operation the greater portion of the mass was removed but it extended posteriorly into the nasopharynx and superiorly bordering on the orbit in which regions tumor tissue was left behind. Pathological examination of the excised specimen showed several nodules of bluish cartilaginous tissue the largest measuring 2 by 3 centimeters. The tumor was soft and broken down in places. Small pieces of bone were attached to the deeper portions of the lesion. Microscopic examination showed it to consist of hyaline cartilage arranged in lobules about the growing periphery where it shaded over into round cell precartilage (Fig 20). In this region there were occasional karyokinetic figures and hyperchromatosis. There was a small amount of calcification in the deeper portions of the tumor and a few small pea sized nodules of osteoid tissue were present. There was recurrence of the tumor following the second operation with the development of a large infected mass which extended backward into the nasopharynx and into the opposite side of the nose. Diagnosis was chondrosarcoma of the maxilla with slight tendency to calcification and ossification. The patient gradually lost in weight and strength and died of the tumor 1½ years later. No autopsy was obtained. In this case the tumor consisted almost entirely of somewhat lobulated hyaline cartilage which showed marked proliferative tendencies at the periphery where the usual microscopic characteristics of malignancy could be made out.



Fig 19 Result 8 years after excision of tumor shown in Figure 15 with replacement of bone transplant

In the following case of chondrosarcoma of the rib there was a marked tendency to calcification and to a lesser amount of ossification.

L. C. Bone Sarcoma Registry No 1030 male aged 20 years had a tumor of the right side of the chest centering about the anterior end of the right fourth rib which had been gradually increasing in size for 2 years. It produced slight pain but there had been no loss in strength or weight. Examination showed a well developed young male. There was a large firm tumor approximately 15 centimeters in diameter protruding from the chest wall and overlapping the second to the seventh ribs. There were no signs of metastases. Operation by Dr. A. D. Bevan revealed a tumor which consisted of cartilage and so involved the chest wall that only the large external mass was removed. The specimen consisted of a mass of cartilage in the shape of a segment of a sphere measuring 12 by 10 by 4 centimeters in its greatest dimensions. The convex periphery was

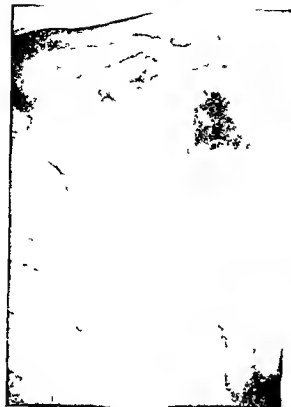


Fig 15 Chondrosarcoma destroying lateral portion of upper end of humerus and stimulating marked ossification in the adjacent bone

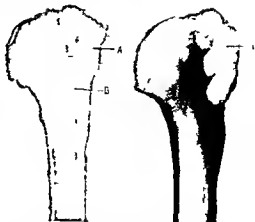


Fig 16 (left) Coronal section showing cartilaginous tumor *a* and the adjacent osteosclerosis is *b*

Fig 17 Roentgenogram of slice of specimen shown in Figure 16 Islands of increased density in cartilaginous tumor *a*

graft from the tibia was inserted into the defect and the patient had an uneventful convalescence. Examination of the specimen revealed a slight bony swelling in the region of the greater tubercle and extending downward for a distance of 1.5 centimeters on the shaft. It was soft in places where cortex had been completely eroded. The articular cartilage was thinned and irregular as a result of chronic arthritis. Coronal section of the bone (Fig 16) revealed a soft tumor mass of mottled brown blue and gray color occupying the region of the greater trochanter and lateral portion of the surgical neck. There was dense bone in the neck and upper portion of the shaft mesial to and below which extended downward for a distance of 1.5 inches. Bony cortex was increased in density along the lower border of the tumor but was absent over its upper portions. The periosteum appeared to be intact in the regions where cortex was completely destroyed. A roentgenogram of a slice, two thirds of a centimeter in thickness (Fig 17) shows the density in greater detail. There are numerous irregular areas of increased density scattered throughout the tumor of the greater tubercle. Microscopic examination of the soft tumor showed it to be made up of richly cellular hyaline cartilage

with scattered small areas of calcification and a small amount of ossification (Fig 18). A few of the cartilage cells showed heavily staining nuclei and there were very few karyokinetic figures to be seen in the section. Sections of the surrounding bone showed it to be markedly eburnated but there were no signs of tumor within its substance. There was evidence of bony erosion at the junction of tumor and bone where lacunar absorption was taking place. Examination of the synovial lining showed fibrous hyperplasia and some lymphocytic infiltration but no signs of tumor. The diagnosis was made of chondrosarcoma of slow growth probably originating in a chondroma. The patient has since remained free from evidences of recurrence and Figure 19 shows a roentgenogram of the shoulder taken 8 years later. There was some new bone formation along the side of the scapula probably derived from periosteum which was taken off in detaching the muscles from the humerus.

Chondrosarcoma of the short or flat bones of the trunk usually begin centrally and break through the cortex forming an external tumor mass without stimulating thick shell formation. The following case of chondrosarcoma of the superior maxilla ran a fatal course with the development of metastases and with extremely little calcification or ossification in it.

J. C. Bone Sarcoma Registry No 1027 female aged 35 years had a painful swelling of the left superior maxilla of 1 year's duration. A firm mass about the size of an egg occupied the region of the antrum and bulged laterally above the gum margin. It was excised and found to consist of cartilaginous



Fig. 21 (left) Cut surface of chondrosarcoma of rib showing calcified and ossified nodules

Fig. 22 Roentgenogram of portion of specimen shown in Figure 21 showing character of shadows in less calcified and ossified lower end

The following case is an example of this type

J. L. Bone Sarcoma Registry No. 1028, male, aged 14 years, entered the University of Chicago Clinics because of a large swelling of the upper portion of the right leg which had developed gradually during the previous 9 months. The swelling was noticed soon after a blow over the upper end of the tibia. For 6 months there had been increasing pain and for 2 months there had been loss of weight and strength. Two months before admission the mass had been incised anteriorly, since which time there



Fig. 24 Chondrosarcoma of cervical spine with blotchy shadows *a* produced by islands of calcification and ossification



Fig. 23 High power view of tumor shown in Figure 21 with heavily staining hyaline cartilage *a* and osteoid tissue *b*

had been an outgrowth of fleshy granulations through the incision. Examination revealed a somewhat emaciated anemic young male. There was a large oval tumor mass involving the upper half of the right tibia with a central fungating area at the point of incision. No inguinal gland metastases. Physical examination was otherwise negative. A roentgenogram of the chest revealed no metastases.



Fig. 25 Section of tumor shown in Figure 24 with zones of proliferating hyaline cartilage *a* and with areas of calcification *b*

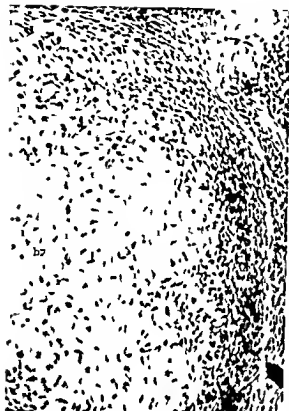


Fig. 6. Histological appearance of nodule of chondrosarcoma of maxilla showing zone of cutaneous growth and mature hyaline cartilage.

smooth and had a fibrous covering. The cut and broken surfaces were irregular. The peripheral portion of the mass consisted almost entirely of bluish hyaline cartilage, but the deeper portion (Fig. 1) contained irregularly scattered islands of yellowish to dark brown dense areas of calcified cartilage and bone. Figure 22 is an X-ray of one half of the specimen showing the blotchy distribution of the calcified and ossified areas. Microscopic examination showed the tumor to consist very largely of a heavily staining hyaline cartilage. In its growing peripheral portions it was thrown into folds and shaded over into richly cellular round cell tissue. In its deeper portions there were irregular islands of calcification and immature tumor bone (Fig. 3). Very few deeply staining nuclei and no dividing nuclei could be seen. Diagnosis: chondrosarcoma of the rib with calcification and ossification. The remaining mass of tumor rapidly increased in size and the patient lost in weight and strength. Metastases developed in the lungs and death occurred 9 months after operation. In this case the diagnosis of sarcoma was difficult to establish by microscopic examination, the picture being more that of a calcifying and ossifying chon-

droma. The subsequent course of events, however, proved that the lesion was a sarcoma.

D. C. Bone Sarcoma Registry No. 103, male, aged 46 years, previously reported by Bassoe, was admitted to the Presbyterian Hospital February 7, 1916. He complained of pain in the right arm for 6 months and the right side of the neck of 5 months' duration. It had gradually increased in severity and for 2 weeks there had been weakness in the right arm and leg. For 2 days there had been weakness in the left arm and leg. Physical examination revealed a small hard mass on the posterior and lateral aspects of the fifth and sixth cervical vertebrae. There was marked weakness in the right arm and leg, and slight weakness in the left arm and leg. All forms of sensation were markedly impaired below the level of the sixth cervical segment, the impairment being more marked on the right than on the left side. A roentgenogram (Fig. 24) revealed slight reduction in height of the body of the sixth cervical vertebra with slight irregularity in its density. The right transverse process of the sixth vertebra had been destroyed and there was a dense irregular shadow occupying a part of the region extending upward toward the fifth vertebra. There were other isolated and branching areas of increase in density extending laterally and downward from it opposite the right transverse process of the sixth cervical vertebra. Operation (Dr. Hevan) revealed a large cartilaginous tumor in the region of the right side of the arch and transverse process of the sixth cervical spine. It extended forward into the body. The tumor was partially removed. It consisted of several particles of tissue bluish in color and containing a few areas of bone and yellowish calcified cartilage. Microscopic examination showed the sections to consist largely of hyaline cartilage. About the periphery of the tumor the cartilage was lobulated and shaded over into round cell precartilaginous. In the deeper portions the cartilage was more mature and was calcified in areas (Fig. 5). There were spicules of bone blood vessel in the areas where the calcified zones had been partly replaced by bone.

The tumor mass in the neck gradually increased in size. The patient developed complete paralysis from compression of the cord and died 5 months after operation. No autopsy.

#### PERIPHERAL CHONDROSARCOMATA

Chondrosarcomata arising peripherally or breaking through the cortex early with the development of a large peripheral lesion are likely to possess islands and branching areas of calcification and ossification which produce a characteristic picture in the X-ray. They may also invade the medullary cavity of the bone, but the characteristic bony proliferation with the formation of a shell, which was seen in the central chondrosarcomata, is absent.



Fig. 21 (left) Cut surface of chondrosarcoma of rib showing calcified and ossified nodules

Fig. 22 Roentgenogram of portion of specimen shown in Figure 21 showing character of shadows in less calcified and ossified lower end

The following case is an example of this type

J. L. Bone Sarcoma Registry No. 1028, male, aged 14 years, entered the University of Chicago Clinics because of a large swelling of the upper portion of the right leg which had developed gradually during the previous 9 months. The swelling was noticed soon after a blow over the upper end of the tibia. For 6 months there had been increasing pain and for 2 months there had been loss of weight and strength. Two months before admission the mass had been incised anteriorly, since which time there



Fig. 24 Chondrosarcoma of cervical spine with blotchy shadows a produced by islands of calcification and ossification



Fig. 3 High power view of tumor shown in Figure 1 with heavily staining, hyaline cartilage c and osteoid tissue b

had been an outgrowth of fleshy granulations through the incision. Examination revealed a somewhat emaciated anemic young male. There was a large oval tumor mass involving the upper half of the right tibia with a central fungating area at the point of incision. No inguinal gland metastases. Physical examination was otherwise negative. A roentgenogram of the chest revealed no metastases.

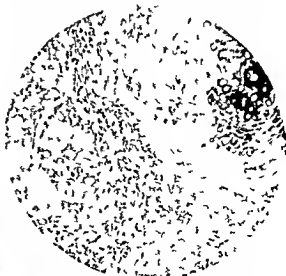


Fig. 25 Section of tumor shown in Figure 24 with zones of proliferating hyaline cartilage c and with areas of calcification b





Fig 26 Tumor of upper end of tibia with dense islands in peripheral portion characteristic of chondrosarcoma



Fig 28 Tumor thrombus shown in Figure 7 composed of hyaline cartilage with islands of calcification

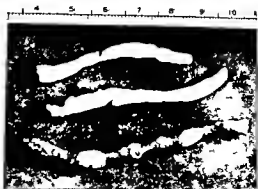


Fig 27 Segments of thrombus consisting of cartilaginous tumor removed from femoral vein

A roentgenogram (Fig 26) revealed a large oval peripheral swelling of the upper 7 inches of the right tibia with extensive irregular reduction in density of the cortex of the metaphysis. The greater portion of the external shadow was posterior to the tibia extending upward into the popliteal space. It contained irregular islands and strands of increased density. The oval shaped area anterior to the tibia was of uniform density and contained no shadows suggestive of calcification or ossification. Roentgenogram of the lungs showed no evidence of metastases. A mid thigh amputation was performed with a constrictor applied over a transvulsion pin at the level of the greater trochanter. When the femoral vein was cut through it was found to contain a tumor thrombus extending in both directions. Traction on the tumor mass in the upper end lodged a bluish white thrombus measuring 11 centimeters in length. Traction on the lower tissue dislodged a thrombus 7 centimeters in length which consisted partly of bluish white tumor and partly of clotted blood (Fig 27). Microscopic examination of the tumor thrombus (Fig 28) showed it to consist of hyaline cartilage which was richly cellular in its peripheral portion and which contained scattered islands of calcification in its deeper portion. It contained no bone. Dissection of the limb uncovered an irregularly spherical firm soft swelling of the upper 16 centimeters of the tibia. Its surface was somewhat nodular but sharply circumscribed. There was a fungating surface 3 by 4 centimeters anteriorly. On longitudinal section (Fig 29) the tumor was found to infiltrate both epiphysis and shaft at that level. The posterior part of the tumor was bluish gray in color. The portion of tumor within the bone consisted largely of spongy bone and calcified and ossified islands were irregularly distributed in the posterior portion of the peripheral tumor. Roentgenogram of a slice 1.5 centimeters thick from the middle of the tumor (Fig 30) revealed irregular reduction in density of the shadow of the old shaft and islands and irregular strands of increased density in the soft parts shadow of the peripheral



Fig 9 Longitudinal section of tumor shown in Figure 26

tumor in its posterior portion. Microscopic sections were made from different portions of the tumor. The unossified portions were found to consist largely of hyaline cartilage with extensive areas of degeneration which shaded over in places into fibrocartilage and connective tissue (Fig 31). Its dense areas consisted of calcified cartilage which in places had been replaced by immature bone.

This tumor appears to have arisen within the bone about the periphery of the posterior part of the upper end of the tibia making a large external swelling and infiltrating the bone and secondarily invading the bone at this level. It had invaded the femoral vein producing a tumor thrombus which extended to the upper limits of the thigh. The main body of the tumor was cartilaginous shading over into fibrous tissue or fibrocartilage on the one side and calcified cartilage and bone on the other. The tissue invading the vein consisted entirely of cartilage. In view of these facts the tumor should be regarded as a chondrosarcoma. The convalescence was uneventful. Nine months later the boy appeared in excellent health and had gained considerably in



Fig 30 Roentgenogram of slice from middle of tumor shown in Figure 29

weight and strength. However a roentgenogram of the chest reveals a circular shadow in the lung about 1.5 centimeters in diameter which has been interpreted as due to a metastasis.

It is not uncommon to find tumors listed in the Registry as osteogenic sarcomata which present large peripheral swellings and roentgenologically show blotchy dense areas which are peripherally located and disconnected from the main shadow of the bone. The gross description usually relates the presence of cartilage in them and examination of the microscopic slides shows a large amount of hyaline cartilage with partial calcification and ossification. A review of these cases would undoubtedly show that some of them belong to the group of chondrosarcomata according to the criteria herein given for that condition.

The condition known as multiple cartilaginous exostoses beginning in childhood and resulting in multiple cartilage capped tumors, especially of the ends of the shafts of the long



Fig. 26 Tumor of upper end of tibia with dense islands of calcification in peripheral portion characteristic of chondrosarcoma



Fig. 28 Tumor thrombus shown in Figure 7 composed of hyaline cartilage with islands of calcification



Fig. 27 Segments of thrombus containing cartilaginous tumor removed from femoral vein

A roentgenogram (Fig. 6) revealed a large oval peripheral swelling of the upper 7 inches of the right tibia with extensive irregular reduction in density of the cortex of the metaphysis. The greater portion of the external shadow was posterior to the tibia extending upward into the popliteal space. It contained irregular islands and strands of increased density. The oval shaped area anterior to the tibia was of uniform density and contained no shadows suggestive of calcification or ossification. Roentgenogram of the lungs showed no evidence of metastases. A mid thigh amputation was performed with a constrictor applied over a transfixion pin at the level of the greater trochanter. When the femoral vein was cut through it was found to contain a tumor thrombus extending in both directions. Traction on the tumor mass in the upper end dislodged a bluish white thrombus measuring 21 centimeters in length. Traction on the lower tissue dislodged a thrombus 7 centimeters in length which consisted partly of bluish white tumor and partly of clotted blood (Fig. 27). Microscopic examination of the tumor thrombus (Fig. 8) showed it to consist of hyaline cartilage which was richly cellular in its peripheral portion and which contained scattered islands of calcification in its deeper portion. It contained no bone. Dissection of the limb uncovered an irregularly spherical firm soft swelling of the upper 16 centimeters of the tibia. Its surface was somewhat nodular but sharply circumscribed. There was a fungating surface 3 by 4 centimeters anteriorly. On longitudinal section (Fig. 29) the tumor was found to infiltrate both epiphysis and shaft at that level. The posterior part of the tumor was bluish gray in color. The portion of tumor within the bone consisted largely of spongy bone and calcified and ossified islands were irregularly distributed in the posterior portion of the peripheral tumor. Roentgenogram of a slice 1.5 centimeters thick from the middle of the tumor (Fig. 30) revealed irregular reduction in density of the shadow of the old shaft and islands and irregular strands of increased density in the soft parts shadow of the peripheral



Fig 35 Microscopic section of periphery of cartilaginous tumor shown in Figure 34 a Fibrous covering of tumor b proliferating zone of cartilage and myxomatous tissue c degenerating zone bordering on cavity

the upper ends of humeri femora and tibiae and on the pelvis clavicles and scapulae at the age of 12 to 14 years. They increased slightly in size and remained small with the exception of a lesion on the lateral aspect of the right tibia. At the age of 27 a tumor mass in this region began to increase in size and at the age of 34 the mass was about the size of a fist. A roentgenogram (Fig 3) showed a large exostosis springing from the posterolateral surface of the upper third of the tibia. It had a broad base and a cauliflower like periphery. The lesion was operated on and partly removed. The wound became infected and since then there was a chronic osteomyelitis with a discharging sinus. Three or four operations were then performed in an endeavor to get rid of the tumor and osteomyelitis but without success. At the age of 37 he came under my care when the upper 8 inches of the fibula and the tumor bridge extending to it from the tibia were excised. On dissection the bridge was found to be composed of spongy bone with a sinus and an osteomyelitic area at its inferior portion. It was capped both anteriorly and posteriorly by thick nodules of encapsulated cartilage extending out into the muscles. Some of the nodules were  $\frac{3}{4}$  inch thick and were broken down internally where they were filled with a mucinous fluid. Microscopic examination showed the nodules to be composed of hyaline cartilage (Fig 33). In places there was degeneration in the central regions and a cellular zone of proliferation along the periphery. No karyokinetic figures were to be seen. The bony portion was composed of cancellous trabeculae and bone marrow. At the junction of bone and cartilage there was a zone of growth where bone was being laid down through cartilage.



Fig 36 Metastasis in medullary canal composed of myxomatous tissue undergoing degeneration and an embryonic type of cartilage

There was severe infection of the operative field with extension to the knee and suppurative arthritis which necessitated disarticulation 3 weeks later. A large anterior flap of tissue which had covered the exostosis was turned back and it carried portions of the tumor which led subsequently to recurrence. Because of infection and retraction of flaps a supra condylar amputation of the femur was performed 5 weeks later. The infected stump gradually healed in 3 months but bony spurs formed on the medial and lateral aspects of the end of the femur. These spurs remained much the same until 21 months later when a soft bluish swelling appeared over the end of the lateral one. This gradually increased in size until 2 months later it measured 2.5 centimeters in diameter and was semifluctuant (Fig 34). At operation skin flaps were reflected and 5 centimeters of the end of the stump was removed.

Dissection of the specimen showed bony spurs on the mesial and lateral sides of the end of the stump and on coronal section there was a large bluish hemispherical cartilaginous mass projecting downward with a base 3 centimeters broad resting on the lateral aspect of the bony stump and exostosis. Its central portion was broken down and filled with a mucinous fluid. Microscopic section of the mass showed it to be composed of a round cell proliferating zone along the periphery which passed over into a layer of immature hyaline cartilage and thus into a deeper layer of degenerated tissue bordering on the mucinous cavity (Fig 35). There were a few heavily staining nuclei in the growing peripheral portion but no cell division was seen. The spurs consisted of mature bone and sections of the end of the stump showed no tumorous infiltration of the old bone.

Within a month small spurs reformed about the sides of the end of the stump and in 12 weeks a semifluctuant tumor had reappeared directly over the end of the stump. It soon became cystic and broke through the scar discharging a mucinous fluid. Three and a half months after the first stump amputation a reamputation through the upper third of the thigh was performed removing 12 centimeters



Fig. 31. Histological appearance of peripheral portion of tumor shown in Figure 9. *a* Hyaline cartilage *b* fibrocartilage *c* calcified cartilage

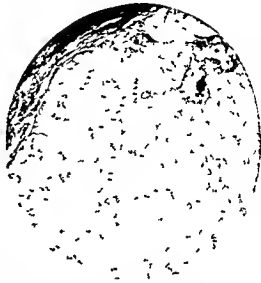


Fig. 33. Section of periphery of cartilage capping the exostosis of tibia

bones is a fairly common disorder, and not infrequently runs in families. Sarcoma developing from one of these exostoses or in a patient with a single exostosis is comparatively rare. In the following case of multiple cartilaginous exostoses a chondrosarcoma developed from an exostosis of the upper end of the tibia.

A. R. Bone Sarcoma Registry No. 1034, male aged 40 years first noticed bony protuberances on



Fig. 32. Cartilaginous exostosis of upper end of tibia with secondary invasion of tibia



Fig. 34. Bone spur on amputation stump with recurrence of cartilaginous tumor over lateral spur

of the tumor remote from the areas casting the shadows in the roentgenogram. The patient was alive and well 5½ years after wide local excision of the lesion followed by radium treatment. While the roentgen ray appearance of this case was typical of chondrosarcoma the microscopic sections that were registered would not permit of its classification with this group although sections from other portions may have shown cartilaginous tumor. However it may indicate that sarcoma originating in cartilaginous exostoses are not always mainly of cartilaginous nature.

Sarcomata arising from enchondromata, according to Mayer, Cornil and Coudray, and Daganello are essentially of cartilaginous nature, but they may grow rapidly, lose their capsules, and become very polymorphic. They are more frequent than sarcomata arising from exostoses. The so called benign chondromata invading veins and producing metastases are in reality chondrosarcomata of slow growth and low grade malignancy. Chondrosarcoma may arise from the costal cartilages, but I have found no instances of their origin from the other cartilages of the body.

That metastases from chondrosarcomata are also cartilaginous and may calcify and ossify is shown by the following case.

Male aged 34 years had had in another hospital amputation of the upper third of the left thigh for tumor of the lower end of the femur which was diagnosed as chondrosarcoma. He died 1½ years later with pulmonary metastases and hypertrophic pulmonary arthropathy. I obtained a portion of lung from autopsy, an X ray of which is shown in Figure 37. It presented numerous nodules varying in diameter from 1 to 5 centimeters. On cut section they were composed of hyaline cartilage with scattered areas of calcified cartilage and bone. These areas cast the blotchy shadow shown in the X ray. Microscopic examination showed the tumor to be composed very largely of hyaline cartilage which in the growing peripheral regions shaded over into round cell precartilage and in the deeper regions was calcified and ossified (Fig. 38).

#### SUMMARY

Bone sarcomata consisting largely of cartilage are best designated as chondrosarcomata. Ten cases were found among 61 bone sarcomata studied.

Irregularly branching strands and islands of calcification and ossification develop in many of them, which cast characteristic blotchy shadows in roentgenograms, making it possible to diagnose the condition pre operatively.

Central chondrosarcoma of the shaft of a long bone may stimulate marked surrounding new bone formation leading to the laying down of a thick wall about it and a thickened shaft beyond it. This also gives a characteristic X ray picture.

Some of the chondrosarcomata arise from enchondromata and cartilaginous exostoses.

Invasion of the veins with the formation of a cartilaginous tumor thrombus has been observed in a number of cases.

Of the 10 cases reported, 1 is alive 10 years after excision, 1 is alive 9 years after amputation and 1 is alive 3½ years after amputation. This in conjunction with the history of long duration in another case (E K) would perhaps indicate a better prognosis than that for osteogenic sarcoma.

#### BIBLIOGRAPHY

1. BASSOE. Some nervous syndromes produced by lesions of the spine. Intern Clin Jbils. 1922 III 220.
2. CORNIL AND COUDRAY. Quelques observations de chondromes et d'ostéochondromes. Rev de chir 1908 XXXIII 213.
3. DAGANELLO. Ein Fall von Chondro Sarkom der Scapula. Arch f path Anat etc 1902 CLXVIII 263.
4. ERNST. Ungewöhnliche Verbreitung einer Knorpel geschwulst in der Blutbahn. Beitr z path Anat u z allg Path 1900 XXVIII 235.
5. MAYER. Beitrag zur Histologie der Chondrosarkome. Muenchen med. Wchnschr. 1906 VIII 2012.
6. FIEBIGER. Geschwulstlehre.
7. SCHNALLS HERMANN. Grundriss der path. Anat. 14th ed. Wiesbaden 1919.
8. SIMON. Ergebn d. Chir u Orthop. 1923 XVI 199.



Fig. 37. Roentgenogram of portion of lung containing four nodules of metastatic chondro-sarcoma that were partly calcified and ossified.

of the shaft of the bone. Dissection of the stump showed broken down faint blue cartilaginous tumor covering the end of the stump and infiltrating the medullary cavity and cortex for a distance of 0.5 to 1 centimeter. On longitudinal section of the shaft a large gray oval metastasis 1.5 by 3 centimeters was found to occupy the medullary canal 6 centimeters above the end of the stump. Microscopic examination of the tumor at the end of the stump showed it to be similar to that in the stump which had been previously amputated. Sections of the metastasis in the medullary canal 6 centimeters higher up showed (Fig. 36) a richly cellular tumor composed of myxomatous cells and hyaline cartilage cells with considerable mucoid degeneration. Karyokinetic figures were fairly abundant. A roentgenogram of the chest revealed no evidences of metastases and there is now no sign of local recurrence 1 month after the amputation.

The local development of the soft degenerative tumor on top of the end of the stump 21 months after the original amputation and the recurrence in the stump after reamputation as well as the histological appearance were highly suggestive evidences of malignancy, but the final evidence was the finding of a metastasis in the medullary canal of the shaft above the stump. The malignant tumor consisted of precartilaginous and myxomatous elements with a small amount of hyaline cartilage and showed practically no tendency to ossification. This was in marked contrast to the original benign tumor of the tibia consisting of mature cartilage which underwent extensive ossification. This patient has two



Fig. 38. Histological picture of tumor shown in Figure 37. *a* 1 proliferating zone *b* hyaline cartilage *c* calcified cartilage.

sons ages 4 and 6, who have multiple cartilaginous exostoses. There are 2 cases of this type in the registry recorded by others, abstracts of which follow.

CASE 343 of the Bone Sarcoma Registry had first a sarcoma develop in an exostosis about the right elbow at the age of 24. The right arm was amputated and the pathological report was osteochondrosarcoma. Nineteen years later a sarcoma appeared on the lower end of the left femur which necessitated a mid thigh amputation. Microscopic examination showed a sarcoma made up largely of hyaline cartilage. It has been variously diagnosed as chondroma myxochondroma chondrosarcoma and osteogenic sarcoma. The patient died 3 years after amputation from acute appendicitis free from evidences of metastases.

CASE 663 of the Bone Sarcoma Registry was that of a rapidly growing tumor of the lower end of the right femur of 3 months standing in a male aged 45 years with very extensive multiple cartilaginous exostoses dating from childhood. Roentgenograms of the sarcoma showed a large soft parts shadow with blotchy irregular islands of increased density in its central portion suggestive of chondrosarcoma. However the sections showed only mixed cell sarcoma without evidence of calcification or ossification. These must have been taken from a portion

This work was followed in 1928 by that of Castle and Locke, which contributed information of a most fundamental nature concerning the disease. These observers conceived the idea that pernicious anemia may be a deficiency disease but argued that it could not be due to a deficiency of liver in the diet, for it is frequently absent from the diet of unaffected persons. They assumed, therefore, that there might be some deficiency in digestion and this is in accord with our knowledge that all patients with pernicious anemia, with possibly rare exceptions, have an achylia gastrica. To test this theory, they fed 300 grams of rare Hamburg steak to normal individuals and removed the gastric contents 1 hour later. This was then incubated and finally administered daily to patients with pernicious anemia. In 8 of the 10 patients so treated there was an effect entirely comparable to that of liver. These observations were controlled by feeding either normal gastric contents or Hamburg steak alone to patients with the disease and thereby demonstrating that both materials were in effective when fed separately. It was concluded that these observations might indicate some deficiency, in the gastric juice of patients with pernicious anemia, which was related to the cause of the disease. On the basis of this work Sturgis and Isaacs were led to try the effect of desiccated hog stomach in the treatment of pernicious anemia and demonstrated that it was as effective as liver if not more so in inducing a remission of the disease.

#### THE EFFECT OF FEEDING LIVER

Since pernicious anemia was first described as a clinical entity by Thomas Addison 80 years ago, it was never demonstrated that any form of treatment produced a prompt and satisfactory remission until the modern form of therapy was introduced. Furthermore, as Evans states, it has never been demonstrated that any other therapeutic measure definitely prolonged a patient's life for a significant period. The only exception to this statement is that the transfusion of blood in some instances may have prolonged life for a relatively brief interval, but all ob-

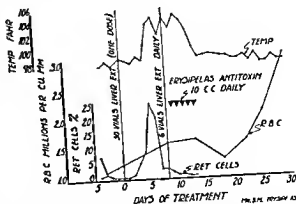


Chart 1 Reticulocyte and red blood cell changes in a patient who developed a severe erysipelas infection. After 4 days of preliminary observation a massive single dose of 30 vials of liver extract equivalent to 3000 grams of liver was administered. With the appearance of the infection the body temperature rose as a result the reticulocyte curve fell and there was a decrease in the number of red blood cells. In patients with pernicious anemia without complications the effect of a single massive dose of liver extract usually persists for 11 or 12 days.

servers agree at present that this type of treatment had only a temporary effect and that it was not curative. The condition has quite correctly been regarded in the past as an invariably fatal disease. In view of these facts the results of the modern treatment are all the more impressive. The immediate effect of liver therapy is prompt, striking, and, with a few exceptions which will be noted later consistently obtained in all patients.

If a patient with uncomplicated pernicious anemia is fed, during a relapse, approximately 240 grams of cooked or raw liver daily, or the equivalent of from 400 to 600 grams of liver in the form of a potent extract, one of the most dramatic changes known to medical science occurs. Within 3 to 5 days after the treatment is instituted the patient changes from an apathetic listless individual to one who is alert and interested in his surroundings. Perhaps one of the most important signs of improvement is the remarkable increase in appetite which is in such striking contrast to the usual anorexia experienced by most patients with pernicious anemia during a relapse. Nausea and vomiting, which may be serious symptoms during a relapse, promptly vanish, the temperature



THE TREATMENT OF PERNICIOUS ANÆMIA BY LIVER FEEDING<sup>1</sup>CYRUS C. STURGIS M.D., RAPHAEL ISAACS M.D. AND MATTHEW C. RIDDLE M.D. ANN ARBOR MEMORIAL  
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**I**N August, 1926, Minot and Murphy (15) recorded for the first time convincing evidence of the therapeutic effect of feeding liver to patients with pernicious anemia. Since then, their results have been adequately confirmed by a long series of observers, so that today the value of liver in the disease is an accepted and established fact. The events prior to this important therapeutic discovery, and the correlated facts which have been observed since that time, have added greatly to our fundamental knowledge of the disease as well as its treatment.

In 1920, Whipple and his associates introduced the idea of feeding liver, by emphasizing its beneficial action in accelerating the regeneration of blood in dogs made anæmic by bleeding. In the following year, Felton published a brief note in the *Iowa State Medical Journal*, in which he stated that encouraging results had been obtained in pernicious anemia by the use of a diet which contained small amounts of liver and of foods rich in iron. In 1923, Gibson and Howard reported elaborate metabolic studies on patients with pernicious anemia and recommended the use of an iron rich and vitamin adequate diet containing liver.

It was not until 1926, however, that Minot and Murphy (15) published the epoch making contribution, in which they clearly demonstrated for the first time two important points: (1) that the red blood cell count of patients with pernicious anemia could be restored to a normal level by the simple procedure of feeding from 120 to 240 grams of liver daily, and (2) that, within a few days after the beginning of the treatment there is a striking increase in the number of reticulocytes or immature red blood cells in the peripheral blood.

Also in 1926, Koessler, Maurer, and Loughlin published their observations stating that a definite relationship exists between a state of chronic vitamin deficiency and certain anæmias. They recommended a high vitamin

diet as treatment and suggested that the meat of the diet should consist of liver, kidney, sweetbreads or brain in 100-gram amounts daily. These observers further stated that this diet was the most promising procedure in the treatment of certain anæmias, especially pernicious anemia. It is now generally believed that this diet was successful in the treatment of pernicious anemia on account of some specific factor in liver and kidney rather than its high vitamin content.

In 1927, a year after the original contribution of Minot and Murphy, was published the work of Minot and Cohn (5), in which they reported the elimination of a high percentage of non essential substances in liver without impairing its potency and gave to the world liver extract for the first time. Stimulated by the introduction of a new and efficient remedy for this otherwise fatal condition, many workers initiated investigations which have thrown important new light upon this disease. One of the first to take advantage of this opportunity was the late Francis W. Peabody of Boston, who appreciated that a unique opportunity was offered to study the bone marrow by biopsy. By this method it was possible to observe the marrow of a patient during a relapse and again after a remission had been induced by feeding liver. His studies confirmed the work of Zadel, who had observed that the bone marrow was red and contained an increased number of megaloblasts during a relapse and became yellow and fatty during periods of remission. Peabody explained the anemia of the relapse as due to the functional ineffectiveness of the bone marrow which results from the failure of the megaloblasts to differentiate toward mature erythrocytes. He suggested that the results obtained by liver may be due to some factor in liver promoting the development of red blood cells. In other words, evidence was presented which suggested that the anemia was more the result of impaired blood production than of increased destruction.

usually produce a decrease in the blood sugar equivalent to about 30 milligrams per 100 cubic centimeters of blood. This decrease begins irregularly during the first week and the maximum fall occurs from within 1 week to 17 days. The cause of the diminished blood sugar following liver treatment is not apparent, but it may possibly be due to an increased demand for carbohydrate.

During the 2 years in which the Simpson Memorial Institute has received patients, we have observed the effect of feeding liver or various types of liver extract to 125 patients with pernicious anemia. As has previously been stated, the immediate beneficial and striking effect of the treatment is now well recognized and no additional statement is necessary concerning it. The information which is much desired at present concerns the length of time a patient with pernicious anemia can remain in good health provided the liver or liver extract is taken continuously in adequate amounts. Unfortunately an accurate and complete solution of this problem has not yet been obtained as the treatment has been used for only a relatively brief time.

In an effort to obtain information on the point, the records of a special group of 42 patients observed at the Simpson Memorial Institute were carefully considered. In all of these patients the clinical evidence of the accuracy of the diagnosis was convincing. Each patient of the group had a red blood count of 2,800,000 cells per cubic millimeter, or less and they all have been observed for a period varying from 6 to 27 months. Thirty-two, or 76 per cent had a red blood count of 4,000,000 cells per cubic millimeter, or greater, at the end of a period varying from 6 to 27 months. In most instances the count had returned to normal in 6 weeks or 2 months and remained normal at the end of the observation period indicated in Table I.

Of the group of 42 patients, 2 are dead. One a woman aged 60 years was admitted with a red blood cell count of about 800,000 per cubic millimeter. She showed a characteristic response to liver extract with a return of the red blood cell count to normal in about 6 weeks. After a year of excellent health her death occurred 1 week after a leg fracture.

Her blood, 2 months before death, was normal and she continued in good health until the time of the accident. The second patient who died was a woman, aged 56 years, who when first seen had a red blood cell count of 2,700,000 per cubic millimeter. She had rather marked cord symptoms, which greatly interfered with walking. After 1 month of liver treatment, the red blood cell count had increased to 4,200,000 per cubic millimeter, but there was slight, if any, improvement in the spinal cord symptoms. Her death occurred about 1 year after she was first seen at the Simpson Memorial Institute. According to her local physician, the blood remained within normal limits throughout, but the spinal cord symptoms were progressive and a complete paralysis of the lower extremities developed, with incontinence of urine and feces. For 1 month prior to death, the patient was drowsy and complete coma was present in the last week of her life. Her death must be attributed to the neurological complication incident to pernicious anemia.

In 10 patients, or 24 per cent of the group observed, the red blood cell count was less than 4,000,000 at the end of a period varying from 6 to 20 months. In each instance, however, a striking improvement in the anemia has followed the treatment and 9 of the 10 patients had, at some time following the liver feeding, a red blood cell count of 4,000,000, or greater. In other words 9 of these patients had been successfully treated but had relapsed. These observations are shown in Table II.

It is important to study the causes which account for the failure of the treatment in hope that recognition of its difficulties will be of assistance in the more successful management of patients in the future. In our experience, the failure to obtain desired results in patients with pernicious anemia was due to three main reasons, as follows: (1) the treatment was not properly administered, (2) the preparations of liver extract were inert or weakly potent, (3) a complicating infection was present.

The most frequent reason for the failure of the treatment is that it is not properly administered. In most instances this is due to

and pulse rate become normal, the patient rapidly gains strength, and the yellowish tint of the skin disappears within 2 or 3 weeks. The average increase in the total red blood cell count is approximately 500,000 per cubic millimeter per week and at this rate the number of red corpuscles usually reaches normal limits within 6 to 8 weeks. Rarely does one see more constant, rapid and satisfactory results from therapy in other diseases.

Additional objective evidence of improvement is usually observed in the form of a substantial gain in body weight. In some instances this is striking. One patient, for example, gained 18.75 pounds in 18 days. Another patient gained 23 pounds in 54 days. In a group of 31 patients with reliable data concerning their change of body weight the average gain in 28 was approximately 8 pounds in an average period of 37 days. In some the increase was even greater than indicated, as the initial weight was determined during a relapse, at which time a variable amount of edema was present, which disappeared as the blood approached normal. This in part masks the actual amount of body weight gained. In 3 patients there was an actual loss of body weight, which may have been due to a loss of edema. One patient had a loss of 15 pounds in 19 days, another a loss of 15 pounds in 18 days, and a third a loss of 0.5 pound in 87 days.

During this period of remarkable clinical improvement, striking changes, both morphological and chemical occur in the patient's blood. Usually on the third day the immature red blood cells, the reticulocytes, appear in increased numbers and rise from an average of about 1 per cent to an average maximum of 15 per cent on the seventh day and then decrease to normal within 2 or 3 weeks. This increase in reticulocytes is characteristically observed in pernicious anemia at the onset of a remission, either spontaneous or induced and is interpreted as indicating an increased activity of the red blood cell forming marrow. When this rise occurs, it can be confidently predicted that the red blood cell count will reach normal limits, provided an adequate amount of liver substance is administered and

no complication, such as an infection, arises. In an attempt to study the curve of the reticulocyte response more closely, Riddle and Sturgis have observed a series of patients with pernicious anemia, who were given single massive doses of liver extract which were equivalent to 3,000 grams of raw liver. Following such a dose, the percentage of reticulocytes was estimated every 4 hours, day and night, for a 12 day period. With this method of treatment, the extent of the curve was approximately the same as when daily doses were administered. The response, however, was somewhat more rapid, as the increase occurred in 48 to 52 hours, the peak was reached on the fifth or sixth day, and the percentage returned to normal in 10 or 12 days.

Although the response of reticulocytes is prompt, it is not the earliest change which occurs, following the use of liver therapy. Riddle has observed that, beginning within 24 hours after the treatment is started, there is an increase in the urinary excretion of uric acid from 74 to 531 per cent and an increase in the concentration of uric acid in the blood serum from 28 to 239 per cent. It has been assumed that the increase in uric acid metabolism results from an accelerated rate of development of the red blood cells and a resultant increased destruction of normoblast nuclei. Since the above work has been reported, corroborative evidence has been supplied by the work of Krafka. This investigator recently observed that the uric acid excretion was doubled in Dalmatian coach dogs after an anemia had been produced by hemorrhage. He likewise concluded that the increase was due to the increased activity of hematopoietic tissue in producing red blood cells with the concomitant destruction of the nuclei of the normoblasts.

In addition to the striking change in uric acid metabolism at the beginning of a remission, there is also definite evidence of a constant decrease in the blood sugar level following treatment. Blotner and Murphy in 1929 reported that whole liver had a blood sugar reducing effect. Riddle has recently demonstrated that various commercial liver extracts likewise exhibit this insulin like effect and

the test Furthermore, each separate lot of liver extract should be tested clinically, for despite careful effort to apply precisely the same methods of manufacture to each quantity of raw material, there may be a wide variation in potency Until all preparations of liver extract are tested clinically, which obviously is associated with many difficulties, or until a more simple method of assaying the product is devised, the only safe procedure is to give the preparation in what is considered to be adequate doses and to observe its effects on the patient's blood at frequent intervals

The chief guiding principle in the treatment of pernicious anæmia with liver is, therefore, an exceedingly simple one, that is, to prescribe an adequate amount of the material and use every possible method to have the patient continue with the treatment, even though the blood is within normal limits There is no evidence to indicate that a special diet in addition is indicated as long as the patient consumes an average and reasonable variety of food This is usually the case, inasmuch as the patient's appetite is stimulated by the liver therapy to such an extent that a wide variety of food in large amounts is demanded Unless obviously faulty dietary habits exist, it is usually satisfactory to leave the choice of food to the individual patient Likewise it is true that there is no convincing evidence that accessory medication, such as dilute hydrochloric acid is necessary, regardless of the fact that the achlorhydria persists when the blood returns to normal and the patient is symptomless In a large percentage of our patients a perfect remission was induced by liver extract without additional medication of any type or special attention to the diet

Of considerable importance in the treatment of pernicious anæmia is the fact that a severe infection may cause the liver treatment to be less effective The mechanism of this is not known but clinical observations of the patients with pernicious anæmia who are undergoing the liver treatment indicate that it is true If a patient's blood has been brought to normal and maintained at that level by the proper maintenance dose of liver or liver extract, a severe infection such as a pychitis

may cause the red blood cell count to fall, even though the dosage remains unchanged It is desirable, therefore, temporarily to increase the liver therapy 50 per cent in amount, when patients with pernicious anæmia develop any type of infection The undesirable influence of infection in diminishing the therapeutic value of liver therapy may manifest itself at the beginning of treatment by a less extensive and slower reticulocyte response If the reticulocyte response has already begun when the infection develops, there is a tendency for the percentage to drop to a low level An excellent example of this is shown in Chart I

#### THE EFFECT OF TREATMENT ON THE CENTRAL NERVOUS SYSTEM LESIONS

As soon as it had been demonstrated that liver has such a remarkable effect in restoring the red blood cells to normal in patients with pernicious anæmia, the question immediately arose concerning the relation of the treatment to the lesions of the spinal cord This is of great importance because approximately 80 per cent of our patients have involvement of the nervous system, although in many instances this is trivial and consists of only a rather mild paræsthesia of the hands and feet Many times the latter almost completely disappears, either permanently or transiently following treatment, and in most patients, regardless of the extent of the involvement, there is a definite improvement in the symptoms referable to the spinal cord

If there is evidence of a widespread spinal cord lesion, with definite indication of injury to the posterior and lateral tracts, the possibility that liver treatment will be of benefit is less promising This is especially true when there is a disturbance in the sphincter control of the bladder, resulting in urinary retention with a subsequent cystitis When this occurs, there is superadded the factor of an infection which, as has been previously stated, causes the liver treatment to be less effective

In general, while it may be said that patients with pernicious anæmia and well marked spinal cord involvement may show a striking improvement with liver therapy, it is true that the neurological symptoms may

the lack of intelligent co operation of the patient, despite the careful instructions given by the physician. To treat pernicious anemia with liver preparations, it is apparently necessary, as with insulin in diabetes and desiccated thyroid in myxedema to administer the proper dosage continuously throughout the patient's life. It has been our custom to give  $\frac{1}{2}$  pound of liver or extract equivalent to 400 to 600 grams of liver, daily until the blood reaches normal limits. At this time, the patient may be placed on a maintenance dose, which is somewhat smaller than the initial dose necessary to bring the blood to normal. In our experience, this dose varies somewhat with different patients, but it is usually  $\frac{1}{2}$  pound of liver, or extract equivalent to 300 or 400 grams of raw liver, 4 or 5 times a week.

In the matter of the maintenance dose, however, which is so important to the health of the patient, there is only one safe rule to follow and that is to require the patient to report for observation at frequent intervals. At such visits the most important single criterion of the adequacy of the dosage is the level of the red blood cells. If the red blood cell count is not within normal limits, this is a definite indication to increase the dosage. In a few instances we have observed the red blood cells and hemoglobin percentage to be slightly greater than normal but there have never been any severe symptoms referable to this condition and there has been a prompt return to a normal level following a decrease in the dosage.

One great difficulty which will always be encountered is the failure to convince the patients that it is necessary to continue with the medication when they are free from symptoms and their blood is normal. Despite our specific directions to continue with treatment and report at regular intervals about 20 per cent of all patients at the height of a therapeutically induced remission discontinue all liver or take it irregularly in greatly reduced amounts. The symptoms of a relapse occur insidiously and patients are often unaware that the blood count is reduced until it reaches the level of approximately 3,000,000 red blood cells per cubic millimeter. With the

discontinuance of liver medication a complete relapse with a decrease in the red blood cells from normal to approximately 1,000,000 may occur in 2 or 3 months.

In an attempt to secure better co-operation from the patients, members of the staff of the Simpson Memorial Institute have recently compiled a small manual containing the simple facts concerning the disease and the essentials of the treatment. It is hoped that this effort to educate the individual patient will prove as successful in the treatment of pernicious anemia as the same method has in the management of patients with diabetes.

Another important cause for failure of the liver treatment in pernicious anemia is the use of various extracts which are of low potency or are completely inert. This arises chiefly from the fact that there is no simple or strictly laboratory method of assaying the strength of the preparation. The only known method of testing the potency of liver extract is to administer it to an untreated patient with pernicious anemia and to observe its effect on the red blood cells, especially the reticulocytes. If an adequate amount of potent material is given and the patient has no complication, such as an infection, experience has taught us that the reticulocytes will rise to a maximum level in inverse proportion to the height of the red blood cell count just prior to the beginning of the treatment. For example, if the patient has a red blood cell count of 1,000,000 the reticulocytes will reach a maximum percentage of about 35 per cent in from 6 to 9 days, if the red blood cell count is 2,000,000 the reticulocytes will increase to a maximum of approximately 14 per cent, if the red blood cell count is 3,000,000 there is slight, if any, increase in the reticulocytes, although the total number of red blood cells will gradually rise to normal.

With such a precise response to the administration of liver or liver extract, this constitutes a very valuable method of testing the efficacy of the material. But application of this test meets with serious obstacles inasmuch as untreated patients with pernicious anemia are not as common now as previously and also not all drug manufacturers have readily accessible clinical facilities to make

TABLE II—RESULTS

Name	Initial		Last		Interval of observation months	Highest		No. of months after treatment was begun that highest count was reached	Cause of failure
	R B C	Hb	R B C	Hb		R B C	Hb		
Cl	22	35	32	70	20	48	85	1	Lack of co-operation
Mi	15	18	36	70	20	43	6	4	Lack of co-operation
Be	12	11	34	73	19	59	91	8	Insufficient liver
Ho	13	16	29	71	18	42	80	7	Impotent extract
Or	11	11	39	70	16	53	76	3	Lack of co-operation
Bo	14	16	39	60	13	42	70	5	Impotent extract and infection
Ba	19	47	34	69	12	42	92	4	Lack of co-operation
Le	18	15	30	69	12	53	80	3	Lack of co-operation
Sch	20	33	23	74	11	43	70	4	Lack of co-operation or impotent extract (?)
Kj	11	12	33	61	6	35	62	3	Impotent extract

NOTE.—In 10 patients or 24 per cent of the total group considered benefit was derived from the liver treatment but the results were classified as unsatisfactory because the red blood cell count was less than 4,000,000 per cubic millimeter at the end of the observation period. In

every patient except one (Kj) the blood had reached normal limits at some time after the treatment was instituted but a partial relapse occurred for various reasons as indicated in the column on the extreme right.

the treatment of pernicious anemia, if given in adequate amounts. There appears to be no therapeutic difference between the effect of beef, calf, or hog liver, although most patients prefer calf liver on account of its better taste and texture. Also it has been demonstrated that kidney, when fed in amounts of  $\frac{1}{2}$  pound daily, produces the same effect as liver (McCann). If a series of patients with pernicious anemia is treated exclusively with raw or cooked liver it soon becomes apparent that it is exceedingly difficult in many instances for some individuals to continue in getting a sufficient amount of liver or kidney daily. Some patients have a natural dislike for such foods and others after a variable period during which they have consumed their prescribed portion daily, develop such an aversion to this form of treatment that they discontinue it despite all warnings that a relapse will follow. On the other hand, there have been some patients who have managed, without difficulty to consume the required amount of liver over long periods, and a few have even developed a keen appetite for it.

Fortunately for those who were unable to continue taking liver, Minot and Cohn and their collaborators (5, 6, 7, 16) began several

years ago to eliminate by chemical methods the constituents of liver which were non essential to the therapeutic effect in pernicious anemia. After a long series of experiments, which they have reported at intervals, they produced an active liver extract (fraction G), a few grams of which are equivalent to 100 grams of raw liver. By the use of this preparation, the equivalent of 500 or 600 grams of liver may be taken by a patient 4 or 5 times a week over long intervals, without difficulty and with an entirely satisfactory result. These same observers have pursued their investigations further, in an attempt to isolate the pure active principle, until they have produced an experimental product which, in as small amounts as 0.6 gram daily, is sufficient to cause a satisfactory effect in patients with pernicious anemia. According to the last report on these experiments, this fraction is free from fat, protein, and carbohydrate, and various reactions indicate that it has the chemical nature of a nitrogenous base.

In addition to the investigations of Minot and Cohn important work has been done by West on the nature of the material in liver, Reznikoff reported the successful administration per rectum of an extract made from cod liver, and Collip has developed a less complex

TABLE I—BLOOD COUNT

Name	Initial		Last		Duration of olse various months
	R	B C.	Hb	R B C.	Hb
Wi	1 0	28	4 2	77	27
De	1 9	43	5 1	75	24
Si	2 4	40	4 4	75	24
Wr	1 9	44	4 1	90	23
McC	1 0	21	4 4	80	22
Ca	1 6	38	4 8	81	22
Ge	1 1	19	4 9	90	21
Sm	1 2	24	4 4	85	20
Jo	1 4	45	5 5	95	0
Ha	1 0	15	4 2	82	18
Cr	1 0	24	4 1	53	16
Wa	1 3	33	4 4	90	16
Bo	1 7	51	4 9	80	15
Sch	1 6	8	4 2	74	15
Zi	1 4	30	4 2	89	13
Re	1 4	34	4 3	85	13
Gu	1 0	23	4 4	73	13
Bi	2 0	47	5 5	94	13
Pe	7	12	5 5	93	12
Fl	1 4	37	5 4	100	12
McF	1 5	51	4 8	90	12
Hu	1 3	35	4 6	76	12
Jol	2 1	46	4 5	55	12
Har	1 7	42	4 0	72	12
Ov	1 2	20	4 9	78	10
Ro	1 4	57	4 7	96	10
Os	9	21	5 3	91	9
Li	8	23	4 1	83	9
Pa	8	24	4 2	70	8
Jon	2 7	58	4 1	81	7
Ki	5	18	5 3	78	6
Co	1 5	40	4 3	79	6
Average	1 4	34	4 6	82	14

NOTE.—The initial red blood cell count and haemoglobin timent on represent the condition of the patients blood when first admitted to the hospital during a relapse. The last red blood cell count shows the effect of liver or liver extract therapy after a period varying from 6 to 27 months as indicated in the last column on the right. In almost all instances the blood rose from its initial low level to normal in 6 to 8 weeks.

remain stationary or may progress even though the liver is given in the most efficient manner which is known at present. The latter statement is of considerable importance, because, with the introduction of this form of therapy to restore the blood and maintain it at a normal level it was hoped that if pernicious anemia were recognized before the appearance of serious cord symptoms in involvement of the nervous system might be prevented. While further experience is desirable before definite conclusions are reached it is obvious at the present time that the

effect of liver therapy is much less marked on the symptoms due to involvement of the nervous system than it is on those referable to the hematopoietic system.

The same statement may be applied to various lesions other than those of the blood, which are frequently involved in pernicious anemia. For example, the troublesome glossitis may disappear promptly when liver is administered. Starr and his co authors have reported a remarkable instance of this and we have seen it in many patients. A few patients in whom there has been a recurrence of the glossitis, even though the blood has remained at a normal level, have been observed.

These facts emphasize a point of importance which should always be considered when appraising the effect of the treatment of pernicious anemia. The benefit of the treatment should not be judged solely by any single criterion but from the entire clinical picture including the patient's symptoms, physical signs, and laboratory examination. It is probably true that the red blood cell count is the best single evidence of the status of patients but a few have been observed who have shown a satisfactory response so far as was indicated by a return of the red blood cells to normal level, yet the haemoglobin remained as low as 50 per cent of normal. These patients are still under investigation and it is possible that some other cause for the persistently low hemoglobin may be discovered, such as occult bleeding or an associated malignancy. Even though their red blood cell count is normal, it cannot be stated that this group of patients has responded in an entirely satisfactory manner to treatment. Likewise, the blood may be changed by treatment from a severe anemia to an entirely normal appearance and with this the patient may show a striking increase in strength and a remarkable general improvement yet he may still be completely incapacitated by severe neurological symptoms.

#### TYPE OF MEDICATION DEMONSTRATED TO BE EFFECTIVE

It has been demonstrated that liver, either cooked or raw prepared according to innumerable household recipes, is effective in

Anemia compiled by Staff, under the special direction of M C Riddle 1st ed Ann Arbor George Wahr

- 1 STARR PAUL, ELLIOTT C A, and NADLER W H Liver feeding in pernicious anemia Med Clin N Am 1927 xi 147
- 22 STURGIS CYRUS C and ISAACS RAPHAEL Desiccated stomach in the treatment of pernicious anemia J Am M Ass 19 9 xc 747
- 23 WEST RANDOLPH and NICHOLS EMILY G Liver fractions in pernicious anemia J Am M Ass 19 8 xc1, 867
- 24 WHIFFLE, G H, ROBSCHKEIT F S, and HOOLER, C W Blood regeneration following simple anemia IV Influence of meat liver and various extractives alone or combined with standard diets Am J Physiol 19 0 lIII 236
- 25 ZADEK J Knochenmarkbefunde am Lebenden bei kryptogenetischer pernicioaser Anaemie insbesondere im Stadium der Remission Schweiz med Wchnschr 1921, b 1087 Blut und Knochen markbefunde am Lebenden bei kryptogenetischer pernicioaser Anaemie insbesondere im Stadium der Remission Ztschr f klin Med 1922 xcv, 66



method of preparing liver extract. Recently Castle (4) has reported a simple household method of preparing an extract, which can be accomplished without knowledge of chemistry and with the use of ordinary kitchen equipment.

In reviewing the modern therapy of pernicious anemia, it is interesting to note briefly that desiccated hog stomach has recently been observed (Sturgis and Isaacs) to be effective in the treatment of the disease and evidence suggests that, per gram of fresh material, it is more active than liver as a smaller amount of material is required to induce a remission. This observation is of great theoretical interest, as it is in accord with the experiments of Castle and Locke and indicates that normal hog stomach tissue contains a red blood cell maturing substance. Whether the therapeutic effect is due directly to an active hematopoietic agent which is contained in the stomach wall, as it apparently is in liver and kidney or to some unknown mechanism, is not yet clear.

The observation that stomach preparations are effective in pernicious anemia is of considerable importance from a practical standpoint, as they have only a slight odor and practically no taste. In addition it appears possible to produce a stomach preparation which will be much less expensive than the preparation of a corresponding amount of liver extract.

#### SUMMARY

Our observations may be summarized as follows:

1. Patients with pernicious anemia show striking improvement following the use of adequate amounts of liver or potent liver extract.

2. Within 24 to 48 hours after treatment is begun, characteristic chemical and morphological changes may take place in the blood, thereby indicating that further improvement will occur if the treatment is continued.

3. The treatment may partially fail if it is not properly administered, if a severe infection develops, or if there is extensive involvement of the central nervous system.

4. Desiccated hog stomach and hog stomach ach defatted with petroleum benzine produce a satisfactory hematopoietic remission in pernicious anemia.

#### BIBLIOGRAPHY

1. ANDERSON T. Disease of the Suprarenal Capsules. London M. Cas. 1849 xlii 51.
2. BLOOMER HARRY and MURPHY W. P. The effect of liver on the blood sugar level. J. Am. M. Ass. 1929 xxi 1332.
3. CASTLE W. B. and LOCKE EDWIN A. Observations on the etiological relationship of achylia gastrica to pernicious anemia. Proc. Am. Soc. Clin. Invest. J. Clin. Invest. 1931 vi 12.
4. CASTLE W. B. and BOWIE MORRIS A. A domestic liver extract for use in pernicious anemia: method of preparation. J. Am. M. Ass. 1929 xxi 1330.
5. COHN E. J. MINOT G. R. FULTON J. F. URBACH H. F. SARGENT F. C. WEARE J. H. and MURPHY W. P. The nature of the material in liver effective in pernicious anemia. J. Biol. Chem. 1927 lxxvi 69.
6. COHN E. J. MINOT G. R., ALLEN GORDON A. SALTER W. T. The nature of material effective in pernicious anemia. J. Biol. Chem. 1928 lxxvii 359.
7. COHN E. J. McMEIKEN THOMAS L. and MINOT G. R. The nature of the material effective in pernicious anemia. III. Abstracts of communications to the Thirteenth International Physiological Congress Boston 1929 p. 55.
8. COLLIP I. B. A method of preparation of a liver extract powder for the treatment of pernicious anemia. Canad. M. Ass. J. 1928 xxvii 102.
9. LYONS FRANK A. Pernicious anemia. Williams and Wilkins Company 1926 p. 127.
10. FELTON R. I. A diet for pernicious anemia. J. Iowa State M. Soc. 1921 vi 50.
11. GIBSON R. B. and HOWARD C. P. Metabolic studies in pernicious anemia. Arch. Int. Med. 1933 xxxiii 1.
12. KOESSLER MAURER and LOCHLIN. The relation of anemia primary and secondary to vitamin A deficiency. J. Am. M. Ass. 1926 lxxvii 476.
13. KRAFAA JOSEPH JR. Endogenous uric acid and hematopoiesis. J. Biol. Chem. 1929 lxxviii 409.
14. McCANN W. S. Effect of kidney on blood coagulation in pernicious anemia. Proc. Soc. Exper. Biol. & Med. 1928 xxv 255.
15. MINOT G. P. and MURPHY W. P. Treatment of pernicious anemia by a special diet. J. Am. M. Ass. 1926 lxxvii 40.
16. MINOT G. R. COHN EDWIN J. MURPHY W. P. and JARVIS HERMAN A. Treatment of pernicious anemia with liver extract: effects on the production of immature and mature red blood cells. Am. J. M. Sc. 1929 lxxvi 500.
17. TEABODY FRANCIS W. The pathology of the bone marrow in pernicious anemia. Am. J. Path. 1927 iii 179.
18. REYNOLDS PAUL. Rectal administration of liver extract (cod). J. Am. M. Ass. 1929 xxi 10.
19. RIDDLE M. C. Work now in progress at the Simpson Memorial Institute Ann Arbor Michigan.
20. SIMPSON MEMORIAL INSTITUTE FOR MEDICAL RESEARCH. A Manual for Patients with Pernicious

Egg yolk and egg white are relatively inert and the average hæmoglobin production is about 10 grams for 2 weeks above control levels

Chicken skeletal muscle (white or dark) is a little less potent than calf muscle, chicken bones and skin still a little below chicken muscle

Gelatin feeding in large amounts will increase somewhat the hæmoglobin output above control levels. It corresponds closely to the effect of beef muscle. We may say that gelatin adds something other than tyrosine or tryptophane to the standard bread ration, which enables the body to fabricate a considerable amount of new hæmoglobin

#### INFLUENCE OF SPINACH, CABBAGE, ONIONS, AND ORANGE JUICE

Spinach and cabbage (red and white) show but a moderate effect on hæmoglobin regeneration in standard anæmia experiments. We may say that from 10 to 12 grams of hæmo-

globin per week above control levels represent their influence on blood regeneration

Iron in optimum dosage added to the spinach ration may give complete summation, that is, the total effect as a rule will amount to the moderate spinach effect plus the larger iron salt effect. This may indicate that the spinach effect is not due to iron in this vegetable

Onions are almost inert when tested in these anæmia experiments

Orange juice likewise is almost inert under these experimental conditions

There is no evidence that various pigments which may be abundant in many fruits and vegetables have any influence on hæmoglobin regeneration

Chlorophyll likewise appears to be wholly inert in these experiments with long continued anæmia in dogs

It seems extremely unlikely that vitamins are in any way concerned with new hæmoglobin production under these conditions

BLOOD REGENERATION IN SEVERE ANÆMIA<sup>1</sup>

G H WHIPPLE M D, ROCHESTER, NEW YORK

**T**HE results which Whipple and Robbins have obtained in four series of experiments in regeneration of the blood in severe anemia may be summarized as follows

## OPTIMUM IRON THERAPY AND SALT EFFECT

The optimum dose of iron by mouth in these experiments is about 40 milligrams iron as metal daily, added to the basal ration iron. Above this level of intake, a large excess of iron salts gives no further rise in the production of hæmoglobin.

Iron has been given in the form of ferric chloride, ferric citrate, ferrous carbonate, ferrous sulphate, and ferrous ammonium sulphate with similar results. The average weekly output of hæmoglobin on the optimum iron salt intake is very close to 25 grams hæmoglobin.

The basal ration of bread contains 20 milligrams of iron as metal per 300 grams bread as fed.

The optimum total intake of iron exceeds threefold the loss of iron by bleeding and wastage of red cells. It is obvious that this iron has some effect in the body other than that of mere replacement of iron in the lost or worn out hæmoglobin.

This iron in excess of hæmoglobin iron requirements obviously exerts some influence upon internal body metabolism so that more hæmoglobin is produced. This may be designated as a salt effect and is probably similar to the effect noted with feeding salt mixtures, copper and other metals and ash from tissues.

Iron is the most potent metal so far tested in severe secondary anæmia due to hemorrhage in dogs.

## INFLUENCE OF MANGANESE, ZINC, COPPER, ALUMINUM, IODINE, AND PHOSPHATES

Manganese by mouth causes very irregular responses, sometimes favorable for hæmoglobin regeneration, sometimes not. Manganese is probably somewhat less potent than copper

salts, which also are uncertain in their reaction in this type of experiment.

Zinc in these experiments shows reactions which are practically negative.

Iron salts in various combinations with manganese, copper, or zinc, give hæmoglobin production levels almost exactly similar to the production expected from the iron alone. There is no evidence for summation of these effects.

Aluminum and antimony in the dosage which is employed show no evidence of a potent effect.

Potassium and calcium phosphates have little if any influence upon hæmoglobin regeneration.

Sodium iodide is to be classed as almost inert and it may even at times inhibit somewhat the salt effect of iron or copper.

## INFLUENCE OF LIVER AND BLOOD SAUSAGE, VEAL, EGGS, CHICKEN, AND GELATIN

Liver sausage as tested in these experiments shows a moderately high potency for new hæmoglobin production, which depends upon the amount of liver contained in the sausage. The output of new hæmoglobin averages about 40 to 50 grams during a period of 2 weeks.

Blood sausage also is quite potent in these experimental anæmias in dogs. It may run as much as one half the potency of whole liver. Its potent factors are whole blood, meat scraps and a little liver. It is probable that the contained blood is responsible for almost half the total effect.

Liver and blood sausage deserve careful study as to their applicability in various human anæmias. As accessory diet factors they may prove to be quite valuable.

Calf skeletal muscle (veal) is as potent as any skeletal muscle so far tested and is in the class with beef heart. In these standard dogs, the production of hæmoglobin will average close to 25 grams for 2 weeks, which is about one fourth the average value for liver.

<sup>1</sup>Abstract of paper presented before the Clinical Congress of the American College of Surgeons, Chicago, October 12-13, 1929.

In order to obtain the best results, treatment must be regulated to meet the needs of the individual. A drop in the red blood cell count and, in consequence, the possibility of increase in symptoms may be brought about not only by the ingestion of an inadequate amount of liver or effective substitute, but also by the occurrence of an infection or some other complicating factor. Complicating factors, other than the acute infections, which occur not infrequently are such conditions as cirrhosis of the liver, arteriosclerosis, pyelitis, and diseases of the gall bladder. If operation be desirable in the presence of any of these complications it will be necessary again to increase the quantity of substance which is being used for the relief of the anæmia.

The occurrence of pregnancy must also be considered as a complication requiring very careful observation and an increase in the amount of liver. If spinal cord changes be present, obviously it would be unwise to allow the pregnancy to continue, because of the danger of an increase in the symptoms due to the probable drop in the red blood cell count. Any drop in the red blood cell count must be considered as of serious import, because of the possibility of the increase or onset of the very distressing neurological changes.

From the laboratory standpoint, the prompt and definite increase in the reticulocytes or young red blood cells following the onset of therapy as suggested early in the use of this method, has been most interesting and helpful in determining the effect of liver or an effective substitute, on the patient. It is possible by means of the reticulocyte reaction to determine, during a period of from 4 to 10 days after treatment is started, the potency of the material fed and to predict the effect upon the red blood cell count.

Other interesting effects of treatment, as observed in the laboratory, are the rapid elimination of the excess of bilirubin in the plasma as indicated by a drop in the icteric index. An increase of the white blood cells and blood platelets occurs and the red blood cells, which are enlarged during the stage of relapse, return to an essentially normal size.

It is surprising indeed that in spite of the very important observations concerning the

effect of dietary measures on anæmia in animals, as carried out by Dr. Whipple and his collaborators, there is still a dearth of accurate information to determine the most effective treatment in man of the so called secondary anæmias from various causes. This is, no doubt largely because of the great difficulty of evaluating the effect of various types of therapy on anæmia in general, a problem which can be solved only by using the several methods of treatment in a series of cases of one type due to a common cause. The scarcity of convincing reports as to the best method of treatment in secondary anæmia probably results also from the following causes: (1) failure to advise the feeding of liver in adequate amounts, (2) failure properly to differentiate between the causes of the anæmias, and (3) administration of certain ineffective substances now available and branded "for use in the treatment of anæmia."

That liver, if given in sufficient amounts, is effective in the treatment of secondary anæmia due to certain causes has been demonstrated beyond question. It is also true that improvement will follow the use of large doses of iron in certain types of anæmia. In order to discuss this subject satisfactorily, it is necessary to classify the anæmias into 6 groups, according to the cause, as follows:

1. Anæmia resulting from acute loss of blood. In this condition there is generally no diminution in the iron reserve and rapid improvement will occur, provided the patient is in general good health. If this anæmia be severe, transfusion may be necessary as a life saving measure, or to prepare a patient for operation.

2. Anæmia resulting from chronic loss of blood. Spontaneous improvement under these circumstances may be very slow and indeed may never be of sufficient amount to bring the patient back to a totally normal condition. This is probably due to the great diminution in the iron reserve, which may be difficult to replace, unless bleeding is stopped. In these cases, transfusion generally has only transient effect, although it is distinctly valuable preceding a necessary operation. After elimination of the source of bleeding, liver or iron, or the combination of the two in sufficient

OBSERVATIONS ON THE TREATMENT OF ANÆMIA<sup>1</sup>

WILLIAM I. MURPHY, M.D., BOSTON.

Peter Bent Brigham Hospital.

THE treatment of anæmia is of interest to both the physician and the surgeon to the physician particularly because of the striking benefits which result from the use of liver in pernicious anæmia, and to the surgeon because of the importance of a knowledge of the most efficient treatment of the secondary anæmias from various causes. In the realm of surgery perhaps no complicating symptom is so uniformly present as that of anæmia. Not only does it influence the work of the general surgeon, but also that of the various specialists—the neurological surgeon, the urologist, and the obstetrician.

Confirmation of the prompt and striking effect of liver in the treatment of pernicious or Addisonian anæmia has been plentiful since the beginning of this form of treatment about 5½ years ago. Although much is yet to be learned in regard to the effective substance or substances in liver, many facts have been established concerning its use.

As was early anticipated, the effective principle has been demonstrated in fairly large amounts in substances other than liver and probably in small amounts, or in an inactive form in still others. The active principle has been obtained in a small fraction which is available for general use in the form of a crude extract to be taken by mouth. A purified extract essentially free from the substances which will reduce blood pressure and which may be used intravenously has been prepared successfully by Dr. E. J. Cohn of the Department of Physical Chemistry of Harvard Medical School and used in several cases by Dr. Minot. This extract contains solids which are by weight about one half of one per cent of the original liver substance. How the active substance does its work is yet to be learned, studies are under way to determine the exact chemical composition of the extract.

Dr. Castle's monumental work on the use of predigested muscle meat in anæmia has helped us to understand the nature of the disease and the rôle which the achylic stomach

plays in the etiology of the disease. Dr. Castle showed that, whereas the ingestion of 250 grams of beefsteak has no demonstrable effect on the blood, if this amount be suitably mixed with normal gastric juice, its ingestion daily will have an effect on the blood comparable to that of about 180 grams of liver. Normal gastric juice alone does not have this effect. This observation indicates that the mixture of meat with normal gastric juice permits the liberation of an active principle comparable in its effect on the blood to that supplied by the feeding of liver. The absence of this reaction in the achylic stomach may have a very direct influence in the development of pernicious anæmia. That the effective substance in liver is not one of the known vitamins has been quite definitely established. Although it is entirely possible that dietary measures other than the use of liver, or an effective substitute, may influence the general condition of the patient, they must be considered as of definitely secondary importance.

It is not my intention to enter into a detailed discussion of this subject, but I would like again to emphasize a few important points. From a clinical standpoint, certain very important facts are available. As was early anticipated, liver itself is not a cure for pernicious or Addisonian anæmia and it is only through continuous and intensive treatment that the best results are obtained. The treatment must be so regulated that the blood will be kept in an essentially normal state. In addition to a red blood cell count of 5,000,000 or more cells per cubic millimeter, it is no doubt necessary to maintain the normal morphological features of the blood. With the blood in this condition, our experience suggests that the soreness of the tongue may be avoided, the diarrhœa which occasionally is present in this disease may be relieved and not only may one expect to avoid the progression of neurological changes, but there will be improvement in these symptoms if they are present when treatment is begun.

<sup>1</sup>Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 14, 1919.

and to Dr. John Powers of the Peter Bent Brigham Hospital for assistance. Dr. Minot and I particularly wish to acknowledge the aid given to Dr. Cohn and ourselves by Drs. Means, Christian, Richardson, and Castle in studying clinically the nature of the substance effective in pernicious anemia.

### DISCUSSION

DR. CHARLES A. ELLIOTT, Chicago: You have listened with interest and I am sure with profit to the papers just read by pioneers in the work of extending the horizon of medical knowledge in this particular field.

You who have followed the work of Dr. Whipple and his associates on pigment metabolism since 1917 have found in their studies an example of persistent logical and unbiased pursuit of a problem seldom equaled in medicine. This has culminated in the establishment of an idea, namely, that blood pigment regeneration and bile pigment excretion can be modified at will by diet and has prompted the suggestion that liver feeding be tried in the treatment of the anemia of pernicious anemia. This work is one of the recent outstanding contributions of physiology to clinical medicine.

Following the reading at the meeting of the Association of American Physicians in May, 1916 of the paper by Minot and Murphy on the clinical results obtained by feeding liver to patients with pernicious anemia and the subsequent publication of the paper in the *Journal of the American Medical Association* August 14, 1926, this method has been given a world wide trial and has received universal support as detailed in the paper of Dr. Sturgis.

Since then our knowledge not only of the type of anemia seen in pernicious anemia but also of the nature of pernicious anemia independent of the blood state has been greatly extended by such men as Sturgis, Cohn, Isaacs, Starr, Castle and many others whose interest in clinical investigation has been stimulated by the results obtained by this treatment of a disease which previously had resisted all forms of treatment.

A few of the results that this study has demonstrated may be stated as follows:

1. The blood state of pernicious anemia is but one feature of that disease. It represents a type of anemia occasionally seen in other diseases notably in sprue and this type of anemia responds typically to liver feeding wherever seen.

2. In addition to the hemopoietic system the gastro intestinal tract and nervous system are also affected in pernicious anemia. These may be independent of any demonstrable anemia. One can count on posterior lateral cord degeneration recognized by competent neurologists as pernicious anemia without anemia and gastro intestinal manifestations of inactivity, glossitis, anorexia, nausea and diarrhea in patients with pernicious anemia who e blood is maintained in approximately normal state by liver feeding. The gastro intestinal and nervous manifestations of pernicious anemia are little if at all influenced by liver feeding even

though the blood state is maintained at normal by this means.

3. The consensus of opinion is that pernicious anemia is a deficiency disease either dietary in the sense that certain necessary substances are wanting in the food intake or more likely a functional deficiency, in that some necessary secretion—an enzyme or a hormone—is lacking in the individual which makes it impossible for him to utilize blood forming elements.

4. Not the least valuable result of this form of treatment and the effects produced thereby has been the stimulus to clinical investigation which the opening of a new avenue of approach in the investigation of this and allied diseases has offered.

DR. A. C. LYNCH, Chicago: We have in the papers of Drs. Whipple, Sturgis and Murphy excellent examples of the application of strictly physiological observations to the treatment of disease. Dr. Whipple working with dog has proved conclusively that certain dietary factors especially liver markedly increase the building of hemoglobin by the blood forming organs. The feeding by Minot and Murphy of liver to patients with pernicious anemia with almost miraculous results constitutes a milestone in the progress of experimental medicine. But why liver and certain other tissues possess this curative property is still an unsolved problem.

The observation of Sturgis and Isaacs that whole stomach is as effective as liver and the observation of Castle that gastric contents from persons with normal gastric secretion also is effective attracts the interest of any physiologist interested in the physiology of gastric secretion.

In 1916 Dr. Farrell and I observed the occurrence of anemia in gastrectomized dogs. Of these 2 died of a grave anemia before we could find a cure. In a third dog which we have had anemic on 6 different occasions during the last 5 years we found that the anemia could be controlled with cod liver oil by mouth and iron subcutaneously. Raw or cooked liver was not effective because it caused a severe diarrhea. Liver extract was effective. Not all dogs deprived of the digestive function of the stomach develop anemia. We have 5 such dogs in the laboratory now with anemia in only 1 other than the 5 year dog. The blood picture of this anemia in dogs does not resemble that of pernicious anemia in man neither does it resemble that of chlorotic anemia. It is not due to hemorrhage. In a dog rendered anemic by the Whipple method kept in that state for several weeks and then gastrectomized the blood returned to normal on a stock diet within a month. Another dog while anemic became pregnant and aborted at 6 weeks. It should be pointed out in this connection that the dog may be so biologically constituted that he will not develop the picture of pernicious anemia as presented by man. Similar work should be done on monkeys.

Being struck by the occasional occurrence of anemia in dogs deprived of their gastric function by the occasional occurrence of pernicious anemia in

amounts and in proper form, will generally relieve this condition rather rapidly. Liver extract is of little or no value. Liver may be used either cooked rather lightly by broiling or as the raw liver pulp. Just what is the most effective means of administering iron has not been definitely determined. Mettler has observed a more prompt and greater rise in the reticulocytes in secondary anæmia following the administration of iron with acid, or an acid iron preparation. That the quantity administered be large is probably of greater importance than the form in which it is given, although there are undoubtedly many preparations of iron which are inert.

3. Anæmias of the nutritional and chronic chlorotic types. Although the chronic loss of blood, or other complications may play a rôle in the development of such conditions, certain pathological states such as achylia gastrica, or a deficiency in the diet may be primarily the cause of the anæmia. Anæmias of these types often improve rapidly following the regular ingestion of a diet containing generous amounts of green vegetables, fruit, and red meat. Improvement will be enhanced by the employment of measures effective in anæmia from hæmorrhage. It may be necessary, however to give even larger amounts of liver or iron than in the latter condition.

4. Anæmia occurring during pregnancy or acutely at the puerperium, due to no clearly recognized cause. The anæmia which arises in pregnancy is influenced favorably by large amounts of liver or of iron, liver extract having little effect. The acute severe anæmias following labor are probably influenced favorably either by transfusion, liver, or liver extract.

5. Anæmia due to chronic infection. It is essential to remove the cause of this anæmia before treatment is begun, otherwise little improvement will be obtained. The same treatment may be employed as in the cases resulting from the chronic loss of blood.

6. Anæmia caused by certain diseases or toxic agents. It may be found in nephritis, tuberculosis, leukæmia, Hodgkin's disease, cancer, and other conditions.

The results of any form of treatment will usually be unsatisfactory until the cause of the anæmia is removed. Each case is, however,

an individual problem and many variations in the anæmic state occur, some of which may be influenced favorably by intensive treatment of a proper sort.

Anæmia is a much more common symptom than is ordinarily supposed. So called neurasthenia, or even mild psychoses, and various states of malnutrition and weakness may result from only a moderate diminution of the hæmoglobin over a long period of time. Proper treatment of the anæmia will often cause striking improvement in the patient's general condition.

The value of liver in treatment of conditions other than anæmia must be determined by critical observations of its effect on groups of similar cases. A small group of patients with biliary cirrhosis showed apparent improvement in general condition and a drop in the bilirubin content of the blood plasma following the ingestion of rather large amounts of liver. Judgment as to the effect of the liver must be influenced by the knowledge that spontaneous remissions may occur. Observation of a small group of patients with idiopathic chronic purpura hæmorrhagica, who have taken liver regularly in large amounts, show sufficient evidence of improvement to warrant further studies along this line.

That liver causes in some persons an improvement in the appetite and so allows a higher caloric intake, with a resultant gain in weight, is of definite interest. This is perhaps because of the effect of the substance contained in liver which reduces blood sugar. Further studies concerning the value of liver in the treatment of the diabetic are being carried on.

I have only briefly commented upon some aspects of the work on the treatment of anæmia which is being carried out at the Harvard Medical School and its allied hospitals and which in large part forms the basis for the opinions expressed here. Much of the work to which allusion has been made, and which has been carried out in response to the original stimulus of Dr. George R. Minot and by the co-operation of many individuals, is as yet unpublished.

I am indebted to Dr. Minot and his associates at the Thorndike Memorial Laboratory of Boston City Hospital

SUPRAPUBIC PROSTATECTOMY WITH CLOSURE<sup>1</sup>

S HARRY HARRIS M.D. CH.M. F.C.S. A SYDNEY AUSTRALIA

THE operation of suprapubic prostatectomy it will be readily conceded, has since its inception always fallen short of the true ideals of surgical procedure. The worst feature, of course, has been the inability to secure first intention healing. Of this the two chief contributory causes have been the lack of precision in the method of hæmostasis and the presence of a ragged postoperative cavity demanding drainage.

As a matter of fact, during the past 30 years comparatively little progress has been made in the actual technique of the operation, the improvement that has occurred in operative mortality being to a large extent due to the pre-operative preparation.

A great deal of effort has been expended on various methods of control of hæmorrhage both by suture and rubber bags and on obliteration of the prostatic cavity by suture. The work of Thompson, Walker, Judd, Lower, Hagner, and Pilcher is outstanding in this respect.

Hitherto to my knowledge, no attempt has been made to reform any part of the torn prostatic urethra nor has complete success crowned any efforts at exact control of hæmorrhage by suture.

At the Australasian Medical Congress held in Dunedin, New Zealand in March, 1927, I showed lantern slides of the technique which I had carried out in 3 cases for the reformation of the prostatic urethra, and ventured to forecast that with the perfection of this technique "the ideal operation of complete closure of the bladder without suprapubic drainage would then be brought within the region of practical surgery."<sup>2</sup>

It was not, however, until 7 months later that I performed my first operation of complete closure.

Previous to this I had in 10 patients tentatively performed the plastic technique as at present, but in conjunction with suprapubic drainage.

The operation had been designed many months previously, but the needle and needleholder had presented an obstacle to its successful performance. The failures with the many types tried had been numerous and disappointing. Eventually I had constructed the present modification of the boomerang needleholder of Young (Fig 21), to whose courtesy I am greatly indebted for sending me the original. This latter, long before, had proved too short and frail. The modification fulfills every requirement.

Lower's operation of complete closure appeared in the *Journal of the American Medical Association* on September 3, 1927, and was brought to my notice some 2 months later at a time when my complete operation had already been performed on 17 occasions.

My operation is, however, essentially different in technique from that of Lower, and the immediate and remote results are uniformly much more favorable than those claimed by him or than would seem possible with the technique which he described.

I have always held that there were three *desiderata* for successful closure of the bladder after prostatectomy. First and foremost, the complete control of hæmorrhage, second, the reformation of the prostatic urethra, and, finally, the obliteration of the prostatic cavity.

The essential features of the operation which I have devised include (1) a series of sutures in the prostatic bed which provides for complete control of hæmorrhage, obliteration of the prostatic cavity, and reformation of the prostatic urethra, (2) complete closure of the bladder and abdominal incision, bladder drainage being provided by a catheter in the urethra, (3) removal of the catheter on the tenth day and re-establishment thereafter of natural micturition without further local treatment.

The operation has been practiced in the past 21 months in 110 of 118 consecutive prostatectomies for benign hypertrophy, including 15 two stage prostatectomies. The

<sup>1</sup> *M. J. Australia* 1927 March 26 p. 461.

<sup>2</sup> Presented before the Clinical Congress of the American College of Surgeons Chicago October 14 1929.



gastrectomized human beings by the relation of achylia gastrica to pernicious anemia in man and by the atrophy of the gastro intestinal mucosa in man we thought that the mucosa of the stomach might produce a substance that had an action on the blood forming organs. In the spring of 1929 Mr. Burgess, Mr. Morgan and myself in co-operation with several physicians fed daily from 400 to 500 grams of partially cooked gastric mucosa from hogs to 4 pernicious anemia patients with negative results on the blood picture. The administration of pepsin also gave negative results but those of liver feeding were positive. The results obtained by Sturges and Isaacs show that whole stomach has a positive effect which indicates that the effect of whole stomach is due to its muscular tissue or a combined action of both muscular and mucosal tissue.

The work of Castle referred to by Dr. Murphy indicates that the normal *in vivo* gastric digestion of meat produces a simple protein substance which has an action on the blood forming organs. Because he obtained negative results with meat digested *in vitro*, or outside the body, he thinks that gastric juice contains some specifically acting substance. This is not necessarily true however because digestion in the body occurs at a more rapid rate unless special precautions are taken than digestion outside the body. Another fact that bears on this point is that raw meat is the only one of the common food substances which contains a natural secretagogue

and that gastric digestion of other foods produces secretagogues that stimulate the formation of digestive juices in general. It may be that a general improvement in digestion due to the feeding of or production by digestion of secretagogues is the cause of the improvement in pernicious anemia. Postmortem autolysis occurs at quite a rapid rate in the liver. So far as we know gastric digestion does not produce vitamins. Complete digestion of a food may be necessary however to release an essential dietary factor from the food complex.

The beneficial action of liver in diabetes and other conditions may possibly be due to its high vitamin content, since Allen and also Mills have found that certain plant extracts by mouth decrease the insulin requirement. Mills has suggested that vitamin B content of such extracts affords the injured pancreas an opportunity for functional recovery and it has been known for some time that pigeons on a vitamin B free diet have a hyperglycemia.

From the papers presented tonight I am sure that we all feel assured that medicine is not satisfied with empiricism but is attempting to determine the whys and wherefores.

#### REFERENCES

1. CASTLE W. B. Brit. M. J. 19 9 1 110
2. FARRELL J. I. and ILLI A. C. Am. J. Physiol. 19 6 1111 189 Northwest Med. 1926 August
3. MILLS C. A. Am. J. M. Sc. 19 3 clxxv 3,6

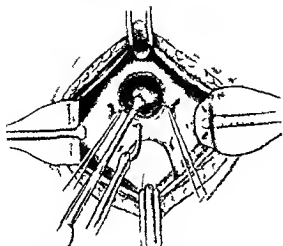


FIG. 4. Beginning insertion of needle for central crown or reconstruction suture

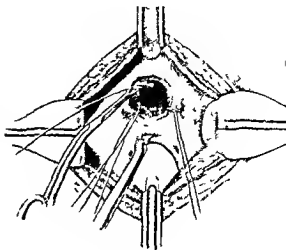


FIG. 5. Needle in position ready to receive the suture from the suture carrier

clean enough to warrant closure with safety, and that practically any bladder possessed by a patient whose renal function is good enough can, except when complicated by the presence of a foul diverticulum with a small orifice be rendered clean by the following technique viz

a The retention catheter is connected by glass and rubber tubing to a bottle at the bed side containing antiseptic. I do not believe that any method of antiseptics will clean up a dirty bladder or prevent infection of a clean one when the catheter is drained into a urinal between the patient's thighs. The catheter is changed at least every third day. A hot bath and urethral irrigation with 1:5,000 solution of oxycyanide of mercury is given between changes. A cream consisting of 1:500 oxycyanide of mercury in tragacanth and glycerine is used for catheter lubrication.

b Bladder irrigation with weak solution of permanganate of potash (of a light pink color) is practiced once or in dirty cases twice daily. Back and forth washing is carried on until the return is clear when the permanganate solution is completely washed out with plain sterile water.

c Four ounces of 1:5,000 solution of nitrate of silver is then run into the bladder and the catheter clamped for half an hour. If the patient will tolerate this strong solution so long. In very dirty cases even stronger solutions up

to the limit of tolerance should be employed. The dirtier the bladder, the greater as a rule the tolerance for nitrate of silver. It is rarely possible, nor is it necessary, to exceed a greater strength than 1:1,250, and even this strength will often not be tolerated. Nitrate of silver used by this method has yielded in my ex-

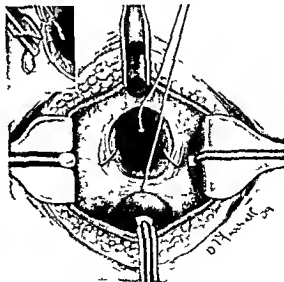


FIG. 6. Prostatic cavity after prostatectomy. The electrically lighted retractors are in position, the two lateral hemostatic sutures have been inserted and tied. The median reconstructive suture is in position but not tied. Inset: Passage of the left lateral suture by means of the special needle and needleholder and ligature carrier.



Fig. 1 Bladder exposed ready for incision. Peritoneal reflection well shown

first operation was performed on October 15 1927. There was no death until the eighth patient. Of the 110 patients 2 died, 1 on the sixth day from pneumonia and 1 on the forty ninth day from inanition. The mortality was 1.8 per cent.

Of the remaining 8 patients who were given suprapubic drainage 1 died (Case 1 Table I). The total mortality for the series was 2.5 per cent.

Table I shows the reasons for suprapubic drainage in the 8 patients who were so treated.

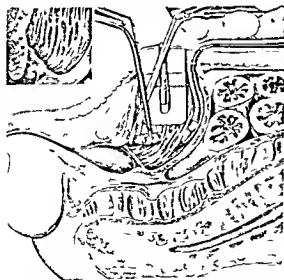


Fig. 3 Sectional view. Removal from anterior region of sphincter of adenomatous nodule discovered during systematic review of prostatic cavity after prostatectomy. Inset: Enlarged view of nodule in natural position.

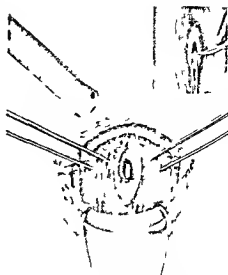


Fig. 2 Layer dissection of bladder. Nozzle of sucker ready for insertion. Inset: Method of cutting mucosa.

TABLE I

	Operation	No. of patients
1	Two stage operation. fat patient. deep pelvis. Technique incomplete. First stage by author.	1
2	Two stage operation. insufficient exposure. low cystotomy elsewhere.	1
3	Hemostasis incomplete. Early case. Needle trouble.	1
4	Inability to pass the No. 3F catheter then employed. Early case.	1
5	Presence of 2 foul diverticula.	1
6	Enormous subtrigonal adenoma filling pelvis. Died after 10 days anuria.	1
	Total	8

#### POSTOPERATIVE HEMORRHAGE

Postoperative hemorrhage demanding suprapubic drainage occurred in 4 of the first 22 cases, due chiefly to errors in technique. Two were reactionary and 2 secondary. All of these patients eventually made good recoveries.

In no single instance in the past 88 cases has the bladder been opened after operation at any time for any cause whatsoever.

#### PRE-OPERATIVE TREATMENT

The pre-operative technique which I employ has been previously dealt with at length.<sup>1</sup> Here it is only necessary to state that prostatectomy is not undertaken until the bladder is

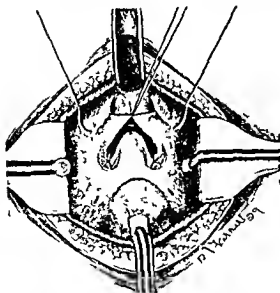


Fig. 10 The first anterior stitch tied the second in position but not tied. Portion of the deep part of the second suture can be seen running deeply across the prostatic cavity just beyond the apex of the trigonal flap

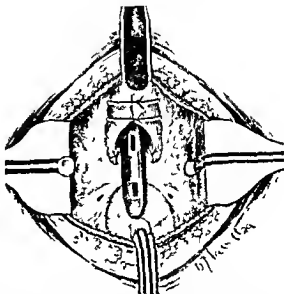


Fig. 11 The plastic operation completed the control of hemorrhage is complete. Catheter in position. Note that ample room is left for drainage upward alongside the catheter into the bladder

The bladder incision is lengthened and retraction sutures inserted

The intra urethral method of bimanual enucleation of the prostate is next carried out and the prostate is removed. The special curved lithotomy forceps, which are employed for the delivery, compress the prostate in its long axis and greatly facilitate this step

The author's electrically lighted bladder retractors are then inserted. Of these, two lateral and one posterior are routinely used, an anterior being added where there is any "overhang" in front such as occurs in patients with deep pelvis (Figs 6, 8, 10, 11, 18, 19, 20)

The prostatic environs are carefully reviewed, any glandular remnants are removed, and the ragged portions are trimmed up so that a nice clean, rounded orifice remains (Fig 3)

#### CONTROL OF HEMORRHAGE

The gross hemorrhage in most cases is readily controlled by insertion of two sutures in the rim of the prostatic cavity at the positions of 4 and 8 o'clock respectively, 12 o'clock being considered the midline anterior (Fig 6). At one or both of these points a bleeding

artery or vein can generally be seen. The suture should be tied in front of the bleeding point if arterial, behind if venous. This is quite important, as inaccurate application of the sutures necessitates their multiplication. Very occasionally an additional suture on one or both sides may be required.

The persistent ooze from the prostatic cavity will be taken care of by its obliteration at a later stage.

The author's modifications of Young's boomerang needleholder and ligature carrier armed with No 2 plain catgut are used throughout for placing the sutures at the bladder neck (Figs 21, 22, and 23).

#### THE REFORMATION OF THE FLOOR OF THE PROSTATIC URETHRA

To accomplish this step of the operation a long pair of angular ring forceps (Fig 24) is passed into the prostatic cavity and picks up the prostatic capsule at a point low down on the posterior wall. This can generally be visualized, though it is not material.

The boomerang needle is now passed entering the mucosa at the position of 6 o'clock and from  $\frac{1}{8}$  to  $\frac{1}{2}$  inch behind the prostatic

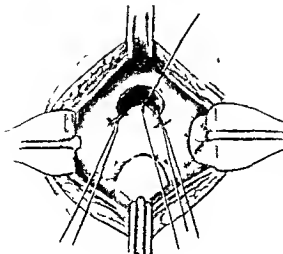


Fig 7 Suture half tied

perience infinitely better results than any of the newer mercurial preparations

My experience, also so far as preliminary vas ligation is concerned, is in complete accord with that of Young. In a long series of operations there has been no case of epididymitis when vas ligation has been practiced at the beginning of treatment

#### OPERATIVE TECHNIQUE

Prior to operation the patient's thighs, genitals and lower abdomen are surgically prepared

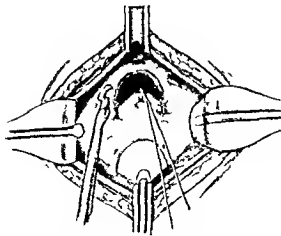


Fig 9 Needle passed and ready to take the first anterior transverse deep obliterative suture

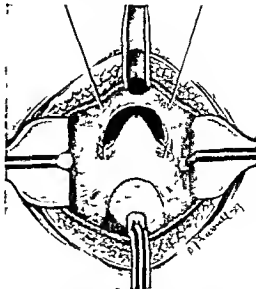


Fig 8 The median reconstructive suture tied down a tongue shaped flap of trigone well down into the prostatic cavity and re forming the floor of the prostatic urethra. The first anterior deep obliterative transverse suture is in position but not tied

Immediately before the patient is brought to the operating theater, the bladder is washed out and completely emptied the catheter removed and the urethra thoroughly irrigated with 1:5,000 solution of oxy-cyanide of mercury

After the induction of anæsthesia the sheets and towels are so draped as to allow access to the rectum, genitals and operation area separately without soiling the field of operation. Two gloves are worn on the left hand, the outermost of which is to be removed after the bimanual enucleation of the prostate

A transverse skin incision is made 1 inch above the top of the symphysis and from 7 to 2½ inches in length, occasionally longer in very fat patients. The aponeurosis is cut vertically to the required extent. There is no undermining of the fat or of the aponeurosis. The bladder is picked up with tissue forceps and the peritoneum is reflected to its summit. The bladder is then opened vertically by layer dissection and any remnant of lotion evacuated through the nozzle of a suction apparatus (Figs 1 and 2). There is complete absence of soiling of the abdominal parietes by urine and lotion flowing over them

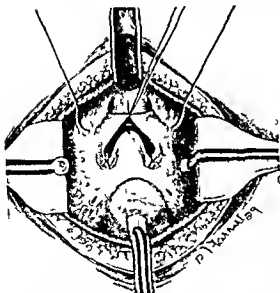


Fig 10 The first anterior stitch tied the second in position but not tied. Portion of the deep part of the second suture can be seen running deeply across the prostatic cavity just beyond the apex of the trigonal flap

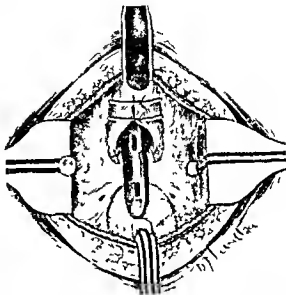


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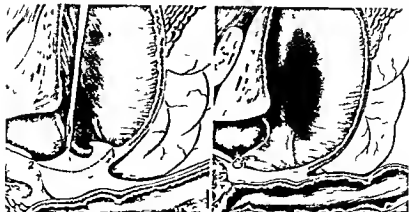


Fig 12 (left) Sectional view showing the method of picking up the prostatic capsule prior to the passage of the median reconstructive suture. The track of this is indicated by the dotted line running between the numeral 1 and 2 which represent the points of entry and exit of the needle.

Fig 13 Sectional view showing the trigonal flap in position re-forming the floor of the prostatic urethra. The median reconstructive and right lateral hæmostatic sutures are shown.

rim emerging deeply in the prostatic cavity, passing below and behind the tissue previously caught up by the ring forceps, and either just picking up or just missing the torn edge of

the prostatic urethra (Figs 5, 6, 7, 8, 12, 13 and 14)

This medium posterior suture passes very deeply through the trigone so that the whole thickness of the underlying muscle is included in its bite. A thick muscular flap with a good blood supply is thus insured.

The tying of this suture not only reforms the floor of the prostatic urethra but also straightens out the trigone, gives to its muscle a *point d'appui* and puts it in position to resume its physiological role of pulling open the internal sphincter during the act of micturition. That this flap remains in the position in which it has been sewed has been amply proved by repeated cystoscopic and cystographic examinations at varying periods after operation. The possibility of the persistence of obstruction or its recurrence from ledge formation at a later date is hereby obviated and any necessity for postoperative urethral dilatation disappears.

#### OBLITERATION OF THE PROSTATIC CAVITY

For this purpose two deep anterior transverse sutures are used, traversing the prostatic cavity from side to side and including in their bite portions of the internal circular and external longitudinal muscle fibers of the bladder which constitute the normal internal sphincter. When these sutures are tied the

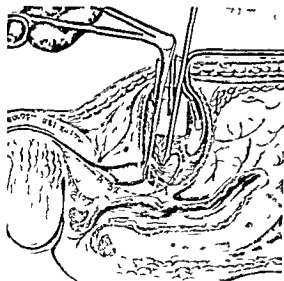


Fig 14 Similar view to Figure 1 showing the method of insertion of the median reconstructive suture. The right lateral and posterior electrically lighted retractors are in position. The forceps have picked up the prostatic capsule preparatory to the passage of the needle, which passes either through or adjacent to the torn edge of the prostatic urethra. The numerals 1 and 2 represent the point of entry and exit of the needle. The numeral 3 is the torn end of the prostatic urethra and 4 is the verumontanum.

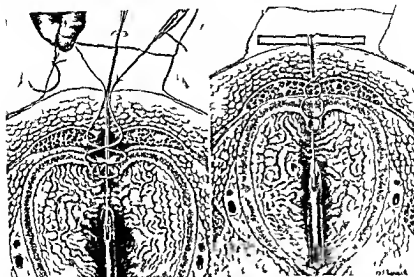


Fig. 15 (left) The method of insertion of the single extended figure of 8 suture which is used for bladder closure. The ends of the silk worm gut suture transfixing the catheter are seen passing out above this suture.

Fig. 16 Sectional view of the completed operation seen from below. The extended figure of 8 suture tied and the space of Retzius obliterated. The catheter is tethered in position to the glass rod lying on the abdominal wall. Note the valve like inversion of the cut edges of the bladder.

muscles on each side are brought together in the midline. There results from this in some cases at least a practical *restitutio ad integrum*.

The first stitch (Fig. 8 and 9) passes deeply in the plane of a tangent to the foremost part of the prostatic ring penetrating the mucosa well out on each side, taking a large bite both in a lateral direction and deeply and just skimming the floor of the prostatic cavity in the depths. This stitch is tied and its ends held taut while the second stitch is passed parallel to the first and about  $\frac{1}{3}$  inch further back (Figs. 10 and 11).

These sutures when properly placed should afford complete control of hemorrhage.

If anything beyond the slightest oozing persists as may happen when a specially large growth has been removed a third transverse suture is inserted posterior to the second.

This completes the plastic stage of the operation.

#### PLACING THE RETENTION CATHETER

A No. 1 rubber catheter which has had a second eye cut  $1\frac{1}{2}$  inches from the tip is now passed through the urethra into the

bladder. It passes below and behind the anterior transverse sutures, lies on, and is enclosed by the strong tongue shaped flap of trigone which forms the floor and sides of the new prostatic urethra (Figs. 12 and 13).

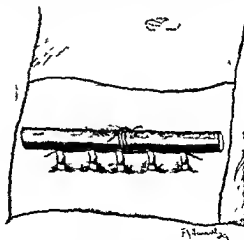


Fig. 17 The operation completed. The skin incision is closed by Michel clips. The ends of the silk worm gut suture which transfixes the catheter are wound in opposite directions around glass rod and tied in half surgical knot.





Fig. 18 The posterior bladder retractor (One fourth actual size.)

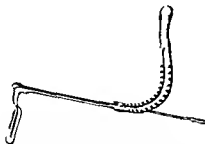


Fig. 19 The right lateral bladder retractor (One fourth actual size.) Note the lamp is placed near the bottom of the blade.

Difficulty in passing the catheter may arise in two situations, at the glans penis and in the newly formed prostatic urethra. The former difficulty is met by meatotomy. In the prostatic urethra, the tip of the catheter sometimes finds its way into the cul de sac on either side of the trigonal flap. This is easily overcome by passing the left forefinger into the rectum and the right down to the prostatic urethra and having the assistant gradually insert the catheter until it impinges upon the right finger tip which then guides it into the bladder. This maneuver is more satisfactory than the use of a catheter guide which is liable to injure the trigonal flap.

The tip of the catheter is drawn up out of the bladder and transfixed by a needle armed with a length of silkworm gut. This latter is used to tether the catheter to a glass rod laid along the front of the abdominal incision. The free ends of the silkworm gut are clipped by a pair of artery forceps. The catheter is then withdrawn into the bladder and so adjusted that the second eye comes to rest at the entrance of the newly formed prostatic urethra (Fig. 11).

The catheter lies loosely in the newly formed urethra, ample room being left for

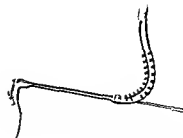


Fig. 20 The left lateral bladder retractor (One fourth actual size.) Note the lamp is placed near the top of the blade.

drainage alongside it upward into the bladder (Fig. 11). Tight suturing around the catheter as around a rubber tube in any other situation in the body, is to be deprecated also on the ground that it is very prone to be followed by sloughing with resultant secondary hemorrhage.

#### CLOSING OF THE BLADDER INCISION

One suture only of No. 3 plain catgut is routinely employed. It is of an extended figure of eight type with three loops, which embrace in order the aponeurosis and recti muscles at the lower angle of the incision, a good bite of the muscular wall of the bladder on either side  $\frac{3}{4}$  inch external to the incision, and finally the cut edges of the bladder.

Valvular closure of the bladder, obliteration of the space of Retzius and closure of the lower angle of the incision in the aponeurosis are thus accomplished (Figs. 13 and 16).

The ends of the silkworm gut, which is used to transfix the catheter, emerge immediately above this suture.

Two mattress sutures of No. 4 plain catgut are placed in the aponeurosis above this. A continuous fat suture and from four to six Michel clips complete the closure.

The free ends of the silkworm gut suspension suture are now wound each in an opposite direction snugly around a short glass rod which lies flat along the abdominal incision. The ends are tied in a half surgical knot and left long and the abdominal dressings are applied.

The catheter in the urethra and the bladder are now syringed with 3 or 4 ounces of 1:10,000 solution of oxycyanide of mercury to free

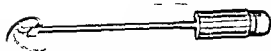


Fig. 21 The combined needle and needleholder. Author's modification of that of Young. The dotted lines show the range of excursion of the needle and of the telescopic handle. (One third actual size.)



Fig. 23 The suture carrier for the needleholder. (One third actual size.)

them of any retained blood clots. A glass tube of the same caliber as the catheter is fixed in its end, and placed in a glass bottle containing antiseptic until the patient is returned to bed.

#### TWO STAGE PROSTATECTOMY WITH CLOSURE

As has been stated the operation is applicable to two stage prostatectomies, but with certain definite reservations, namely, the preliminary cystotomy incision should be placed not less than  $1\frac{1}{2}$  inches from the top of the symphysis, and at least one month should be allowed to elapse between operations for subsidence of the wound induration.

The incision is carried vertically downward and there are added, if necessary, two lateral incisions which radiate from the fistulous opening.

Special narrow bladed electrically lighted retractors are necessary on account of the restricted space available. There is rarely, however, any particular difficulty in carrying out the complete plastic technique. These cases are of course more likely to leak during the early part of the convalescence than the one stage prostatectomies, but it is surprising how little leakage actually occurs.

There is of course no reason why the hemostatic plastic technique on the prostatic cavity should not be applied through the ordinary wide abdominal incision with daylight exposure, should the operator so desire. Personally I employ this exposure on occasions



Fig. 2 The author's needles for use with the needleholder. The larger is  $1\frac{3}{8}$  inches, the smaller 1 inch in length.

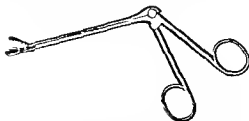


Fig. 4 The forceps for picking up the prostatic capsule. (One third actual size.)

when diverticula also have to be removed. There is naturally a greater liability to infection of the perivesical planes and abdominal parietes, and it is probably safer to use rubber dam drainage in the space of Retzius for a day or two after operations in which this exposure has been used.

#### THE AFTER TREATMENT

The convalescence is extremely easy for both patient and attendants. For the first 24 or 36 hours a careful watch must be kept on the catheter to see that it does not become obstructed by small clots. The urine during this period, though blood stained, should be quite transparent. When there is any doubt as to the continuity of the drainage there should be no hesitation in injecting into the bladder at any time  $\frac{1}{2}$  ounce of 1:3,000 solution of nitrate of silver, though no set irrigation is employed.

The catheter is connected up to a bottle at the bedside and is retained in position until the tenth day. Very rarely is there any urinary leakage from the wound during this period. Immediately before the removal of the catheter 2 ounces of 1:3,000 solution of nitrate of silver are injected into the bladder. To remove the catheter it is necessary only to cut

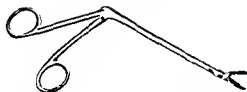


Fig. 2. Alligator clip for trimming the prostatic cavity. The one shown cut toward the right. Another pair which cuts to the left is also suitable.



Fig. 26. Hemostatic forceps of occasional use for application to the prostatic rim.

across the silkworm gut suspension suture at the skin level. The hairpin shaped remnant of silkworm gut comes away with the catheter. The nitrate of silver solution is generally passed *per urethram* within  $\frac{1}{2}$  hour and natural micturition follows thereafter.

No urethral dilatations have been found necessary at any time after operation.

Occasionally from the fifth to the tenth day the wound has become puffy and elevated and fluid is evidently present. In such cases it has been found necessary merely to pass a pair of sinus forceps through the skin alongside the silkworm gut suture. Blood stained turbid, or even offensive pus has been evacuated through this small opening which generally closes in 2 or 3 days without any urinary leakage. There is not that tendency to infiltration of the abdominal parietes which is associated with infection in a large transverse incision when no drainage is employed.

In some few of the cases there has been urinary leakage through the wound after removal of the catheter but this has been short lived.

The patient is out of bed on the eleventh day.

### CONCLUSIONS

The operation as described brings suprapubic prostatectomy into line with modern operative procedure, and may fairly be described as an operation of precision.

The operation has been practiced in 110 out of 118 consecutive prostatectomies in the past 21 months for benign hypertrophy of the prostate, with 2 deaths. The mortality was 1.8 per cent.

Including the 1 patient who died in the series of 8 subjected to postoperative suprapubic drainage the mortality of the whole series works out at 2.5 per cent.

The technique is applicable to two stage operations when the preliminary cystotomy has been performed according to the method prescribed.

The operation accomplishes by suture complete and permanent control of hemorrhage, obliteration of the prostatic cavity and reformation of the prostatic urethra.

The comfort of the convalescence and the simplicity of the nursing are in marked contrast to the common experience with the usual method of suprapubic drainage.

## STANDARDIZATION OF ELECTROSURGERY

RADICAL OPERATION FOR CANCER OF THE BREAST TAKEN AS AN EXAMPLE IN GENERAL SURGERY<sup>1</sup>

NELSON H. LOWRY, M.D., F.A.C.S., CHICAGO

**F**OLLOWING in the march of industry, surgery is passing from the age of iron and steel to the period of electrical development.

Very early in the art of surgical intervention the hot iron was used for the searing and separation of pathological tissue. Abscesses were opened, superficial tumors were burned off, and deep incisions were made for gall stones and other abdominal complaints. The sterilizing, as well as the hemostatic effects were well understood and appreciated by medieval surgeons, and the literature of that period shows many descriptions of cautery technique. A good textbook was published by C. Bartholinus in 1624, at Hafnir. A well preserved copy of this excellent treatise may be seen in the library of the Surgeon General, Washington, D. C.

The soldering iron was too slow for modern surgeons, so an electric heating unit was devised to keep the iron hot. The electric cautery became a mighty weapon, and a modern cautery literature began to develop.

Dr. James I. Percy's work on the malignant uterus and Dr. A. C. Scott's operation for carcinoma of the breast by the actual cautery should be mentioned as examples of what can be done with slow heat.

High frequency currents now entered the arena and drew the attention of the surgeons as a whole. Beginning with Professor Oudin's demonstration in Paris in 1893 of fulguration for the cure of superficial cancer, the users of high frequency electricity quickly added electric cutting and electrocoagulation to their accomplishments. The generators were large and expensive and the working tools were awkward and cumbersome and were often the target for humor and satire but the work went on.

For about 5 years in Germany and in this country modified radio transmitters have been used for generating high frequency currents for surgical purposes. There were many

objections to these early generators. Fast cutting with insufficient coagulation permitted bloody fields, where the current slowed down or stalled altogether. Irritating spark jump and muscle jerking were also very objectionable.

A recent survey of the surgeons of this country using electricity in the operating rooms gave very interesting information. The object of this survey was the discovery of the kinds of electricity really necessary and desirable in surgical work. It seems that there have been two distinct schools in electro-surgery, the cutting school and the cooking school. Between these there is more or less of a fixed gulf and what one has found useful the other refuses to investigate. The cutters require fast cutting with minimum coagulation for the skin, muscles, etc., so that they may perform rapid and extensive dissections and obtain primary healing. They further require slow cutting with maximum coagulation for the brain, liver, pancreas, lung, and other organs that are delicate in structure and abundant in blood supply. The cooks require a heavy current that is easy to insulate for electric coagulation of large or small areas. They also need a current similar to the original

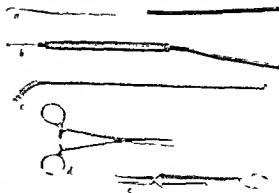


Fig. 1. a, Cutter; b, coagulator; c, insulated suction tube; d, Ochsner forceps; e, Boyens clamp.



Fig 2

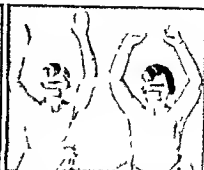


Fig 3

Fig 2 Patient on right breast operated upon 7 years ago Adenocarcinoma. Left breast operated upon 1 year later for extension growth Midline incision four and one half years ago local recurrence

Fig 3 Patient on left bilateral amputation 7 months ago for adenocarcinoma. Note good functional result



Fig 4 In order to remove more tissue in all advanced cases we prefer to do a bilateral operation at once

Oudin current for fulguration and dessication of superficial lesions

Only a few surgeons were trying to combine the good points in both schools. Of these the brilliant work of Dr Harvey Cushing on intracranial tumors stands out as the greatest accomplishment of electrosurgery of our time. He used two machines, a cutting and a coagulating machine controlled by one switch board. He called attention to the need of cutting currents of various degrees of coagulation as well as a coagulating current. He also stressed the need of a smooth current of suitable wave form that would eliminate muscle jerking and convulsions.

The result of the survey clearly showed the necessity for both cutting currents and coagulation currents and to gain speed it seemed necessary that these currents operate synchronously without the need of a special operator to throw switches or change con-

trols. With this object in view extensive research was made involving all known spark gap high frequency generators as well as the common radiofrequency transmitters.

It was found that it could be done better by tubes. The result is a small dependable generator that gives three cutting currents, two coagulating currents and in addition a fulgurating current similar to the original Oudin resonator current. The cutting and coagulating currents operate synchronously and without interference so that as the surgeon cuts the first assistant may use the coagulator to dry up the bleeding points not sealed by the cutter. The coagulating current is of low voltage and easily insulated. A momentary touch is sufficient to seal ordinary bleeding but when large vessels are encountered they are grasped by artery forceps and the forceps are touched with the coagulator. This seals all tissue within the grasp of the forceps.



Fig 5 Dissection of subclavian and axillary region is completed before the work around the breast is begun

Sponging has been eliminated in favor of an insulated suction tube, which keeps the held dry without trauma. In deep areas and in friable tissue, such as the lung or the cervix uteri, a momentary touch of the coagulator to this tube seals any bleeder at the exposed distal tip.

It must be borne in mind that great heat is given off and if the coagulating current is used too freely primary union cannot be expected. This is especially true of the skin and mucous membranes.

A classification of all cautery agents suggested by our survey is submitted.

1 Actual cautery—(a) soldering iron, (b) Paquelin cautery, (c) electric cautery.

2 High frequency (spark gap, damped high frequency generator)—(a) fulguration, (b) electric cutting, (c) electric coagulation.

3 Radiofrequency (vacuum tube undamped radiofrequency transmitter)—(a) desiccation, (b) electric cutting, (c) electric coagulation.

#### RADICAL BREAST AMPUTATION FOR MALIGNANCY

You must not get the idea that removal of the breast and surrounding tissues by the radiofrequency cautery is more complicated and laborious than sharp dissection. On the contrary it is more simple and speedy, as you will see.

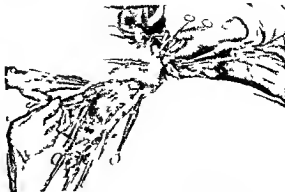


Fig 6 It is thus that the mammary gland with pectoral muscle, the coraco-clavicular fascia, the structures of axilla are removed in one large mass.

We have found sponges and sponging, too traumatic, too time consuming, and too dangerous as regards infection and local implantation of living cancer cells.

High powered suction applied by a medium size, straight metal tube is used to maintain a dry field at all times. This tube is insulated except at its tip and its distal end. If the exposed distal end be touched by the coagulator the tip of the tube instantly becomes a coagulator. One dozen artery forceps are in readiness to pick up large vessels and one dozen Doyen towel clamps are used at strategic points on the skin margins to maintain traction and when once attached their position is not changed.

The method of procedure is as follows. With the cutting electrode plugged in at medium (fast if the patient is obese) the skin incision is outlined with the same slow stroke and light touch that one would use in drawing.



Fig 7 Coagulator is being applied to a large vessel in the grasp of the forceps. Insulated suction tube at right and cutter at left.



Fig 2

Fig 3

Fig 2 Patient on right breast operated upon 7 years ago Adenocarcinoma Left breast operated upon 1 year later for extension growth Midline incision four and one half years ago local recurrence

Fig 3 Patient on left bilateral amputation 7 months ago for adenocarcinoma Note good functional result



Fig 4 In order to remove more tissue in all advanced cases we prefer to do a bilateral operation at once

Oudin current for fulguration and dessication of superficial lesions

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latissimus dorsi muscle behind. This undermining leaves only enough fat attached to the skin to make a comfortable flap. The dissection then uncovers the ribs and intercostal fascia. It is thus that the mammary gland with the pectoral muscles, the coraco-clavicular fascia, the structures of the axilla and all surrounding tissues between the skin and the ribs are removed in one large mass. Enough skin should be removed near the

primary growth to prevent skin recurrences but the extensive undermining and removal of fat is far more important. Most local recurrences have been in the superficial fat near the midline or near the latissimus dorsi, showing that the undermining has not been extensive enough.

In order to remove more tissue a bilateral amputation is advised in all cases in which the growth has reached an advanced stage.





Fig. 8 The dissection has been completed. It will be noted that the entire field is dry.



Fig. 9 Free drainage draws all serum to surface. This serum may contain living cancer cells.

with a fine pen. The first assistant follows the incision with the suction tube to maintain a dry field. He seals small bleeders at once by applying the coagulator to the suction tube for a moment or two. Large bleeders are seized by Ochsner forceps and the forceps momentarily touched with the coagulator.

While the first assistant is handling the suction tube and coagulator, the second assistant places the Doyen towel clamps at strategic points along the skin margin. The clamps serve as retractors and when once placed are not changed during the operation. Clawing the tissues with ordinary retractors causes trauma and may cause implantation of living cancer cells.

With hemorrhage controlled and the skin flaps retracted a clear field is always ahead for the surgeon who steadily separates the tissues with the cutter in his right hand and an Ochsner forceps in his left for the occasional spurt. This makes for very fast dissection as there is no delay of the team as a whole.

You may follow any classical method preferred. We use the incision of W. L. Rodman clearing out the subclavian structures first. By extensively undermining the skin flaps the pectoralis major comes into view. It is clamped off near its insertion and severed between clamps with the cutter. The first assistant then applies the coagulator to the clamps and removes them. The structures of the axilla are now beautifully exposed from above.

By carefully maintaining a dry field, the

long thoracic is seen just below and parallel with the tendon of the pectoralis minor, while the acromiothoracic appears just above the tendon. These two arteries and accompanying veins are carefully avoided as the tendon is clamped and severed near its insertion into the coracoid process.

The cutter is now plugged in at slow speed and the costocoracoid membrane opened. This exposes the apex of the axilla and the axillary vein. Dissection now progresses from above downward, gauze being used over the left index finger and the cutter or slow speed in the right hand. As the structures of the axilla are thus uncovered the pectoral muscles are retracted downward and inward and an excellent view obtained.

The acromiothoracic and the subscapular branches of the axillary artery are encountered from above downward with their accompanying veins they are carefully clamped and divided and coagulated. The dissection progresses to the base of the axilla where large glands are frequently encountered. As we near the margin of the latissimus dorsi muscle the long subscapular and the posterior thoracic nerves are identified and preserved. All axillary glands, fat and the blood vessels and lymphatics supplying the breast have been cleared away before the work on the breast begins. The second skin incision is now made an inverted cone being outlined about 3 inches at its base with its tip extending beyond the costal margin about half way to the umbilicus. Extensive undermining is again resorted to beyond the midline in front and to the

Figure 1 shows the incidence of wound infection on this service during this epidemic. The upper curve represents the total percentage of wound infection, the lower that of hemolytic streptococcus infection.

Again, during this epidemic, study of all the customary causes of infection gave negative results. At the same time, the mouth and nose of each surgeon, interne, nurse, and student were repeatedly cultured. This study revealed a large number of hemolytic streptococcus carriers. A check-up showed that one or more of these carriers had been in close contact with the operations upon those infected with the hemolytic streptococcus.

Again, study of the masks revealed that they were woefully inefficient, as far as they could be considered germ proof. In the absence of other positive evidence, it seemed fair to deduce that this epidemic of streptococcus infection was probably due to streptococcus carriers inefficiently masked.

Dr. George H. Bigelow describes an epidemic of respiratory disease in Massachusetts in the winter months of 1928-1929. He states among his conclusions that one fourth of the population was sick with this infection. Thus among our patients and operating room personnel there was the possibility of 25 per cent having active or latent respiratory disease at this time. We note this evidence again to show the possible relationship between epidemics of respiratory disease and those of wound infections due to hemolytic streptococci.

We do not attempt to explain the large percentage of infections due to organisms other than the hemolytic streptococcus during this epidemic in the second hospital. Furthermore, we do not wish to create the impression that wound infections as a whole can be traced to those of the operating room personnel who are carriers of pyogenic organisms.

We believe that other factors, including the resistance of the patient to infection, whether from without or from organisms existing in the blood stream or in foci at the time of operation, play an important rôle.

However, we do feel that such carriers of pyogenic organisms, in the presence of an

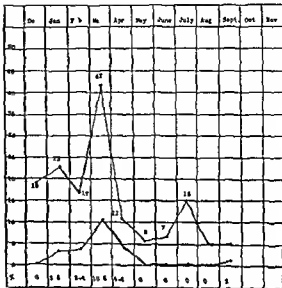


Fig. 1. Cases of wound infection in first hospital. Upper curve total wound infections, lower curve hemolytic streptococcus infections.

unsatisfactory masking situation, constitute a weak link in our aseptic procedure which may account for a certain number of wound infections.

Naturally, there arose the question as to whether or not other hospitals throughout the country had experienced similar epidemics of wound infection. A questionnaire shown in Figure 2 was sent to 100 hospitals by the American College of Surgeons.

Replies were received from 60 hospitals. From the percentage of replies, one might conclude that the number of wound infections in hospitals throughout the country was not large. Nevertheless, it is our impression that while the number of wound infections in any hospital in a single month is small, the aggregate number throughout the year in the hospitals of this country would be considerable.

In answer to the first question, 16 replied that there had been seasonal epidemics of wound infection, 44 replied in the negative.

In reply to the second question as to the relationship between the incidence of wound infections and epidemics of respiratory disease, 8 agreed that such had occurred, 2 were doubtful, and 50 replied in the negative.

## HOW CAN WE DETERMINE THE EFFICIENCY OF SURGICAL MASKS?

IRVING J WALKER MD FACS BOSTON

From the Pathological Laboratory Boston City Hospital Dr F B Mallory Director and the Harvard Surgical Teaching Service Boston City Hospital

THE fact that the etiological factor in many wound infections after surgical operations could not always be satisfactorily explained aroused my interest in this question. This interest was further stimulated, in August, 1927, when opportunity arose to study 3 deaths from hæmolytic streptococcus infection in a hospital located in a suburb of Boston. These deaths occurred after operations for conditions which should have made possible recovery with "clean" wounds. The patients were operated upon on 2 successive days by the same surgeon with the same assistant and operating room personnel. In each case, evidence of wound infection developed within 24 hours after operation and before the first dressing was done. Wound and blood cultures showed the hæmolytic streptococcus. No focus of infection was discovered in the patients themselves. No other group of infections had occurred in this hospital during recent years.

The customary investigation of sterilizers was carried out and the sterility of catgut and the strength and sterility of the alcohol were investigated. Inquiry was made into the methods of hand and operative field preparation, including examination of these for infected areas. All yielded negative findings. At the same time attention was focused upon the possibility that someone who had assisted in all three operations might have been a hæmolytic streptococcus carrier. We were further moved to investigate this phase of the matter because during this period there was an epidemic of respiratory disease in the area about Boston. It was found that 3 of the 6 people associated with these operations were hæmolytic streptococcus carriers. Incidentally it was found that 50 per cent of the nursing personnel of the hospital were similar carriers. Operating was suspended for a week and after that all found to have hæmolytic streptococci in the mouth or nose were eliminated from the

operating room. Since then once a month during the summer and twice a month during the winter and spring cultures are taken of the noses and mouths of the operating room personnel of the hospital to determine the bacterial flora.

In our investigation it was also found that masks were used to cover the mouth but the nose was covered in but few instances and further that the masks themselves were far from germ proof. A germ proof mask, which will be described later, was then devised. This mask is now worn by all the nurses in the operating suite and by many of the physicians.

The following facts were brought out in an analysis of this series of wound infections.

1 The infections were of a hæmolytic streptococcus nature and occurred at a time when an epidemic of respiratory disease was present.

2 Fifty per cent of the operating room personnel were carriers of hæmolytic streptococci.

3 The masking situation was inefficient.

4 Since that time, following the elimination of streptococcus carriers from the operating room, and the use of a germ proof mask worn by most of the personnel, there has not been a single instance of hæmolytic streptococcus infection.

Another series of wound infections, some of which were due to the hæmolytic streptococcus occurred during the winter and spring months of 1928 and 1929 on a teaching service of another hospital located in Boston. On this service in addition to the usual operating room personnel, there are also present in the operating room at one time 8 to 10 students and often several visiting physicians. Rigid aseptic technique is adhered to. All in the room wear gowns or white coats and all mask the mouth and about 50 per cent mask the nose. For better teaching purposes, spectators are allowed to gather about the operating table.

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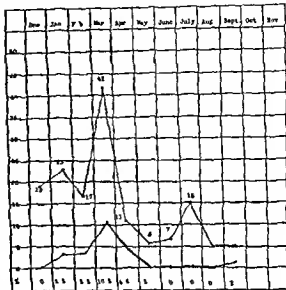


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## QUESTIONNAIRE

I If seasonal epidemics of wound infection occurred in your hospital please check the months during which they have occurred

January	April	July	October
February	May	August	November
March	June	September	December

II Have these epidemics of wound infection been associated with epidemics of respiratory diseases?

III Please indicate the usual custom of the operating room personnel or incidental visitors in masking

Mask only Nose and mouth

- 1 Operating surgeon
- 2 First assistant surgeon
- 3 Second assistant surgeon
- 4 Surgical nurse
- 5 Assistant nurses
- 6 Visiting supervisors or other nurses
- 7 Visiting physicians
- 8 Other visitors

IV Please give a description of the mask used in your hospital or if you prefer submit a sample to us for analysis

Hospital  
By

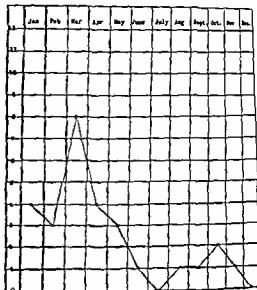


Fig. 3 Monthly curve of wound infections as reported in 14 hospitals

Fig. 2 Questionnaire relating to the use of masks

The curve of monthly incidence of wound infections as reported by those admitting such epidemics is shown in Figure 3. The curve representing the infections during the early months of the year corresponds fairly well with our curve of infections in 1929 in the second hospital shown in Figure 1.

The answers to the second question would seem to indicate that the larger proportion of hospitals believed that there was not a relationship between epidemics of respiratory disease and those of wound infections.

As indicated earlier in this paper, from our experience we feel that such a relationship does exist. We are convinced, as are other writers, that the prevalence of streptococcus carriers has a decided relationship to that of respiratory disease. We also feel that such carriers have a positive relationship to the incidence of wound infection.

Our view is substantiated by the work of Meleney in a study of streptococcus wound infection in the Presbyterian Hospital for the years 1925 and 1926. We agree with Meleney that while streptococcus carriers are most common during epidemics of respiratory diseases, such carriers may be found at any season or month of the year.

Study of the answers to the third question

regarding the method of masking the various individuals in the operating room personnel was not of as much positive value as we had hoped, so varied were the replies.

Where those of the personnel in intimate contact with operations masked the nose and mouth, 24.2 per cent of hospitals reported epidemics of wound infection. Of those masking only the mouth, 32.5 per cent reported such epidemics. Slight as the difference is, the evidence nevertheless tends to show that the incidence of wound infection is less when both nose and mouth are masked.

A study of our hemolytic streptococcus carriers convinced us that the nose less often than the mouth harbors streptococci, and usually a lesser number in the nose in the individual having streptococci in both nose and mouth. This observation may explain why certain hospitals where only the mouth is masked have been fortunate enough to have had few streptococcus wound infections.

With the germ proof mask which covered only the mouth of such a carrier, our experimental work proved conclusively that with streptococci present in both nose and mouth and with the latter covered with the germ proof mask, these organisms would be deposited upon the Petri dish during the ordi-

nary act of respiration. We concluded, therefore, that masking the nose as well as the mouth should be adopted as a standardized procedure for all those in the operating room.

#### STUDY OF MASKS SUBMITTED

Our aim in this study was to determine which of the masks submitted could be considered germ proof.

Of 60 hospitals 42 submitted masks for analysis. Of these 42 masks, 22 masks were found to differ either in design, the nature of the material, or the number of layers of the material used. Practical experience in early work on masks was sufficient for us to decide from inspection alone that 15 of the 22 masks studied could not possibly be germ proof and hence were not tested in this respect. That left us 7 masks to investigate.

The minimum standard which we had established for a germ proof mask was that the mask should be so constructed that no organisms could pass through it when the wearer with both the nose and mouth covered talked for one hour's time during the last 15 minutes of which the area of the mask in front of the mouth was moistened. This might, at first thought, be considered a rather severe test, since no operator would continually talk for 1 hour during an operation. On the other hand many operations do continue beyond the period of 1 hour's time.

Our investigative work on masks was carried out in the following manner.

The student whose mouth at the time showed the greatest number of hemolytic streptococci or in absence of the hemolytic streptococcus the viridans type was chosen as the subject. An open Petri dish containing culture media was placed in the room but at a distance from the subject. This served as a control for air contamination. We laid stress upon the difference in the bacterial flora found in the air control and that in the dish before which the subject had talked. The use of streptococcus carriers as subjects served as another means of determining whether or not the organisms passed through the masks. On no occasion did we find the hemolytic streptococcus or the viridans in the air control.

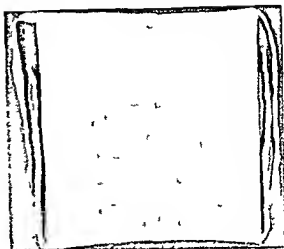


Fig. 4 Mask devised by writer

The subject unmasked, read a certain passage from a book for 15 minutes. During the reading a Petri dish lay upon the table in front of the subject at a distance of  $1\frac{1}{2}$  feet from the mouth and at an angle of 30 degrees from a line drawn perpendicular from the mouth to the table. With the nose and mouth masked the same passage was read with another Petri dish in the same position.

The media were then incubated for 48 hours, when colony counts were made of the growths on the three Petri dishes. In making our computation to determine the growth on the dishes exposed to the tests, with and without the masks, we deducted from the count of each of these dishes the number of colonies found in the air control, considering that this represented as near as we could estimate the amount of air contamination. We then had figures representing the number of colonies produced by the subject speaking without a mask to compare with those when the subject wore a mask.

If the count in the dish used when the subject was masked showed a great increase in the number of colonies over that of the air control, the mask was deemed not germ proof. Again if streptococci were found in dishes used in the test with the subject masked and, as was the case in each instance, none was found in the air controls, we had further evidence that the mask transmitted organisms.

If the mask seemed germ proof, or in case of doubt, the test was run for one hour during the last 15 minutes of which the area about the mouth was moistened with saliva. If no organisms were then transmitted, the mask was considered to be satisfactory. We would submit this method of procedure for consideration in testing out the efficiency of any mask as to whether or not it is germ proof. We realize that greater accuracy might have been assured had the test been carried out in a room free from organisms. We had no such room available.

Our study of the 7 masks convinced us that none could be considered germ proof. There was variation in the periods of time during which the masks were germ proof, and also some difference in the degree of efficiency in the same period of time. All masks tested transmitted organisms, more freely when damp than when dry.

We then set about to devise the ideal mask, the requirements of which we considered to be

1. The primary cost should be low to fit in with other economies of hospital administration. For the same reason, the mask should be one that could be used repeatedly, would stand up under laundering and sterilization and would still remain germ proof.

2. The mask should be comfortable and not unduly warm when worn to cover both nose and mouth, otherwise it would not be readily accepted by surgeons. It should not cause fogging or condensation of moisture on the lenses of those wearing glasses.

3. Lastly, it must not permit the passage of organisms when dry or moist during prolonged periods of conversation.

Although we have given much time and thought to the experimental work, we regret to say that we are unable to present to you the ideal mask. However, we should like to submit a mask for your consideration and analysis. We trust that it may stimulate greater interest in the subject of wound infection and its possible relationship, if any, to carriers of pyogenic organisms and to epidemics of respiratory disease. We trust that eventually the present method of masking will become something more than a perfunctory

procedure and that future study will result in the devising of an ideal surgical mask.

The mask which I wish to describe is made in the following manner (Fig 4). A piece of rubber, 6 inches square (we have found discarded rubber gloves to be a desirable source of supply) is incorporated between two layers of gauze 10 inches square. The edges of the latter are turned in and stitched on three sides. The third side is left open in order to facilitate the replacing of rubber when necessary. The rubber is stitched in at the upper part of the mask where it will cover the area over the nose and mouth. At the upper part of the mask there is incorporated a small piece of aluminum which can be bent to fit the nose of any individual. Tapes are attached to each of the four corners. The mask is worn in the usual way.

Its primary cost is negligible. It can be laundered and sterilized up to five times. It should be made of gauze that is shrunken otherwise washing may shrink it so that it will be too small. If too small, it will be uncomfortable and warm when worn.

If large enough, the mask will be comfortable in the cool weather but rather uncomfortable in hot weather. With conditions of increased humidity, especially in hot weather, there will be fogging or accumulation of moisture on the lenses of glasses. We have overcome fogging by using on the lenses at different times one of several preparations on the market to prevent fogging. We have not been able to overcome the moisture from condensation, which happily has occurred in Boston on only a few days during the year.

The mask has been proved to be germ proof. Theoretically, one might expect organisms to be expelled about the sides, but experimental work has proved that this is not the case.

Until a better mask is devised it may be useful, should you deem it advisable, to wear at least during the winter months or when an epidemic of respiratory disease is prevalent.

#### REFERENCES

1. BIGELOW, GEORGE H. *New England J. Med.* 1909, CCL 274.
2. MELENKY, FRANK L. *J. Am. Med. Ass.* 1910, LXXVI, 1397-1399.

HOW CAN WE INSURE THE STERILITY OF CATGUT?<sup>1</sup>

FRANK L. MELENEY M.D. New York

WITH THE ASSISTANCE OF

MABEL CHATFIELD NEW YORK

From the Bacteriological Research Laboratory of the Department of Surgery, College of Physicians and Surgeons, Columbia University and Presbyterian Hospital

IN 1923 in one of the large hospitals in New York City, within a few days of one another, two cases of gas gangrene developed in operative wounds. *Clostridium oedematis maligni*, the vibron septique organism, was recovered from both of these wounds. One patient died from the infection. The other recovered following an amputation. The catgut used at the operation was suspected and other tubes from the same batch were cultured and were found to contain not only living vibron septique spores but several other species of spore forming anaerobic bacteria. The relatives of the patient, who died, accepted it as an unfortunate but unpreventable accident. The patient who lost his leg sued the catgut firm and a judgment was given in his favor. The court made the catgut firm legally responsible for the infection and for the subsequent loss of limb, and in the trial it was brought out that adequate precautions had not been taken to insure the sterility of the catgut.

In 1925 in another New York Hospital 5 operative wound infections occurred which were symptomatically gas gangrene. These 5 patients were all operated on within 4 days of one another and not one of the 5 survived. The writer had the opportunity of studying one of these cases bacteriologically and found a virulent spore forming anaerobic bacillus of the gas gangrene group. Again the catgut from the batch used during those five operations yielded not only this same organism in two of four tubes examined, but four other species of spore forming bacteria including the common gas bacillus of Welch—*Clostridium welchii* or bacillus aerogenes capsulatus. This study and a description of the organism, which was thought at the time to be a new species of gas gangrene bacillus, was reported in the December number of SURGERY, GYNECOLOGY AND OBSTETRICS.

1927 (7) It was later discovered that Dr. Sordelli, of Buenos Aires, had found the same organism in an operative wound infection and had reported it briefly in an Argentine journal in 1922 with an abstract later in a French journal. We therefore accorded Dr. Sordelli priority of discovery. (5) In a subsequent communication from Dr. Sordelli, the writer was informed that the source of the infection was thought to have been catgut, but material was not available to him for cultural proof.

Close contact with the two disastrous episodes just described led the writer to inquire into the whys and wherefores of such events and to wonder whether or not something could be done to prevent further catastrophes of that nature. The following questions came to mind:

- 1 How often do these infections occur?
- 2 How often are they reported in the medical literature?
- 3 Where does our catgut come from?
- 4 Does it contain virulent bacteria?
- 5 How is it sterilized?
- 6 Do the bacteria resist the "sterilizing" process?
- 7 Are processes which destroy resistant spore forming bacteria detrimental to other advantageous physical properties of catgut?
- 8 Are the several steps of the sterilization process checked with self recording pressure and temperature instruments?
- 9 How is catgut tested for sterility after it has been put through the sterilizing process?
- 10 Who can sell catgut?
- 11 Is there any law or other regulation requiring proof from firms selling catgut of the sterility of their product?
- 12 Do the firms test their own catgut?
- 13 Do outside bacteriologists test the catgut for the firms?
- 14 How often are these tests done?



If the mask seemed germ proof, or in case of doubt, the test was run for one hour during the last 15 minutes of which the area about the mouth was moistened with saliva. If no organisms were then transmitted, the mask was considered to be satisfactory. We would submit this method of procedure for consideration in testing out the efficiency of any mask as to whether or not it is germ proof. We realize that greater accuracy might have been assured had the test been carried out in a room free from organisms. We had no such room available.

Our study of the 7 masks convinced us that none could be considered germ proof. There was variation in the periods of time during which the masks were germ proof, and also some difference in the degree of efficiency in the same period of time. All masks tested transmitted organisms, more freely when damp than when dry.

We then set about to devise the ideal mask, the requirements of which we considered to be

1. The primary cost should be low to fit in with other economies of hospital administration. For the same reason, the mask should be one that could be used repeatedly, would stand up under laundering and sterilization and would still remain germ proof.

2. The mask should be comfortable and not unduly warm when worn to cover both nose and mouth, otherwise it would not be readily accepted by surgeons. It should not cause fogging or condensation of moisture on the lenses of those wearing glasses.

3. Lastly, it must not permit the passage of organisms when dry or moist during prolonged periods of conversation.

Although we have given much time and thought to the experimental work, we regret to say that we are unable to present to you the ideal mask. However, we should like to submit a mask for your consideration and analysis. We trust that it may stimulate greater interest in the subject of wound infection and its possible relationship, if any, to carriers of pyogenic organisms and to epidemics of respiratory disease. We trust that eventually the present method of masking will become something more than a perfunctory

procedure and that future study will result in the devising of an ideal surgical mask.

The mask which I wish to describe is made in the following manner (Fig. 4). A piece of rubber, 6 inches square (we have found discarded rubber gloves to be a desirable source of supply) is incorporated between two layers of gauze 10 inches square. The edges of the latter are turned in and stitched on three sides. The third side is left open in order to facilitate the replacing of rubber when necessary. The rubber is stitched in at the upper part of the mask where it will cover the area over the nose and mouth. At the upper part of the mask there is incorporated a small piece of aluminum which can be bent to fit the nose of any individual. Tapes are attached to each of the four corners. The mask is worn in the usual way.

Its primary cost is negligible. It can be laundered and sterilized up to five times. It should be made of gauze that is shrunken; otherwise washing may shrink it so that it will be too small. If too small, it will be uncomfortable when worn.

If large enough, the mask will be comfortable in the cool weather but rather uncomfortable in hot weather. With conditions of increased humidity, especially in hot weather, there will be fogging or accumulation of moisture on the lenses of glasses. We have overcome fogging by using on the lenses at different times one of several preparations on the market to prevent fogging. We have not been able to overcome the moisture from condensation, which happily has occurred in Boston on only a few days during the year.

The mask has been proved to be germ proof. Theoretically, one might expect organisms to be expelled about the sides, but experimental work has proved that this is not the case.

Until a better mask is devised it may be useful, should you deem it advisable, to wear at least during the winter months or when an epidemic of respiratory disease is prevalent.

#### REFERENCES

1. BIGELOW, GEORGE H. *New England J. Med.* 1919, vol. 74.
- MELENEY, FRANK L. *J. Am. M. Ass.* 1917, LXXVIII, 139-1394.

taminated catgut I wrote to the government Bureau of Standards of the Department of Commerce to find out if it had any jurisdiction or control over such matters, and they replied that they had no control over sterility but the Army and Navy had certain requirements for tensile strength. I was referred to the Public Health Service and they too replied that "firms engaged in the preparation of this material are not required to subscribe to any standard test furnished by the 'Public Health Service'." Finally I appealed to the American College of Surgeons and received a prompt and hearty response. They were eager to find out how I proposed to remedy the matter and promised every possible co-operation to achieve the desired end. The end is simply this—that it shall not be possible for anyone to buy on the market catgut that is not absolutely sterile. I believe that you will all agree with me in this, that there should never be any competition of catgut firms in the matter of sterility. Their products may vie with one another with respect to other physical characteristics—tensile strength, absorbability, and what not, but they should all have the common factor of sterility. There is no relativity about sterility, it is an absolute term which means the absence of living elements.

Now, just as there is more than one way to kill a cat, there are more ways than one to destroy bacteria in catgut. We do not care how they are destroyed but we want to know that they are destroyed. We are not interested in the various processes by which catgut is sterilized, but we are interested in knowing that the final product is sterile. It is for the various catgut firms to find out what processes will destroy the bacteria and retain the desirable properties of catgut.

As far as I can determine, there are ten or a dozen firms in this country selling so-called "sterile" catgut. Many hospitals prepare it for their own use. The firms may be said to be in three categories. First, those which maintain their own laboratory where samples of every sterilized batch of catgut are put through a test to determine whether or not any living organisms remain. Second, those firms which send samples of each batch to

neighboring bacteriologists and depend on their reports regarding the purity of the product. Third, still other firms which do not send samples of every sterilized batch but check their methods from time to time by sending occasional samples to outside bacteriologists for testing. It is obvious that if the tests are so designed that the media is not a favorable environment for the growth of certain bacteria known to be present in raw catgut, the tests are worse than useless because they give a false sense of security. In other words, the method must be adequate to detect any living organism which may be present and sufficient time must be given for it to grow out in the medium. Furthermore, no matter how fool proof the method of sterilization may be, something might go wrong, let us say, to be conservative, once in a thousand times and there should be a means of checking up on such failures. In other words, not an occasional batch but every single sterilized batch should be tested. Time and space must be given to store this material until the test is complete, and it must not be liberated, even in emergency, until the tests have shown it to be free from contamination. If a method of culture can be devised which will be absolutely certain to pick up any living organisms no matter how few in number they may be, and if all catgut firms will agree to use this method and test every batch of sterilized catgut, the chance of purchasing an unsterile product by doctors and hospitals would be reduced to a minimum and they could buy with more confidence than they do now. This would extend the field of sale to include those doctors and those hospitals who fear to purchase catgut on the market because of their doubt with regard to the factor of sterility.

Any method which is devised for testing sterility must first be demonstrated to be efficient—that is the *sine qua non* of its acceptability for those who use the product, but it must also be as economical as possible and adaptable to large numbers of specimens tested at the same time, in order that it may be acceptable to those who make the product. We must first of all demonstrate to the users that the test is the most efficient yet devised and they will accept the products of those

15 Are these tests adequate to reveal any and every living spore still present in the catgut?

16 How often is any attempt made to prove catgut at fault when operative wound infections occur?

17 What methods are used for such tests?

18 Is catgut frequently exonerated by negative tests with ordinary bacteriological methods when it is really at fault?

Considerable time, thought, and experimentation has been given to these and other related questions but I will not burden you with details. Certain pertinent facts, however, have been brought to light which point irresistibly to the necessity for regulation in this matter and for direction of it by some recognizable authority, such as the Hospital Standardization Committee of the American College of Surgeons.

It is difficult to find out how frequently "accidents" of this kind happen. Such cases are not usually reported in the literature. If they occur it is often thought that the less said about the matter the better. Most doctors and many hospitals do not have the facilities for making adequate anaerobic bacteriological tests, and unless a case is proved by culture the evidence is not complete. The doctor may suspect but if he cannot prove, he cannot blame. He can change to another brand of catgut, and not infrequently does so. The firm loses a customer and is sorry for that, but it is soon forgotten and nothing is done about it. It is only fair to state that catgut may be wrongly suspected and blamed for certain infections or even deaths due to other causes. Perhaps this is more often true than when it escapes deserved blame, but the fact remains that it has been proved to be at fault on many occasions, and, when it is at fault, serious consequences follow.

A short while ago the writer sent out a questionnaire to 106 surgeons including all of the heads of the department of surgery in the medical schools of the United States and Canada asking if in their experience or that of their staffs any cases of infection or tetanus had occurred attributable to catgut. Of the 49 who replied, 36 gave an unqualified "No." Five said that they had suspected catgut impurulent

wound infections but could not prove it. Two suspected but did not prove catgut to be the cause of certain cases of postoperative tetanus. One reported a proved case of tetanus and 2 reported proved cases of gas gangrene. One Canadian correspondent reported a large series of tetanus infections in several Canadian cities attributed to a single brand of catgut.

It is difficult to say whether the 37 who did not reply would have given a greater percentage of positive answers than those who did reply, and it is also difficult to say that this group was a representative cross section of the surgical profession from this particular point of view. Nor can one say that, in the smaller hospitals with curtailed budgets, such accidents occur more often. For several reasons, therefore, it is difficult to find out how often these infections occur. Dr. William Welch wrote me that it was because of the occurrence of gas gangrene proved by him to have been due to catgut that Dr. Halsted gave up the use of catgut entirely and turned to silk. Since then other virtues have been attributed to silk, and catgut may be better prepared now than it was in those days, but the fact remains that Dr. Halsted's pupils and followers all over the country are not using catgut because, first of all, Dr. Halsted felt that there was always the threat of infection.

Catgut ligatures are made from the submucosa of the upper portions of the small intestine of sheep. Certain cheap grades contain some pig gut. After removal from the animal, the contents are stripped out, the mucous membrane and muscular coats are removed and the submucosa is washed, twisted, and dried. It is obvious that it must contain bacteria commonly present in the upper intestine of the animals and that the more resistant organisms will be dormant in the gut almost indefinitely unless destroyed by heat or chemicals.

There is no legal restriction on the purchase of the raw material, anyone may buy it either fresh or salted, and may prepare it in any way that he sees fit. He may then proffer it for sale to anyone who wishes to buy. The government has rigid laws which limit the selling of impure or adulterated and poisonous foods, but is not at all concerned with con-

may receive your active support and thus the desired effect may be accomplished. Thus, we hope, will mean not only the elimination for ever of mortality and morbidity from contaminated catgut but the elimination also of the fear of such accident. The results of our preliminary study are given in the addenda which appears below.

#### ADDENDA—PATHOGENIC SPORE FORMING ANAEROBES CULTIVATED FROM RAW CATGUT

It should be understood that the common pyogenic organisms are easily destroyed by relatively low temperatures and relatively high dilutions of antiseptics while the degrees of temperature and the concentrations of chemical antiseptics which are required to kill spore forming organisms approach closely to those which alter the physical properties of catgut and render it useless for surgical purposes. It is the spore forming organisms which are most likely to survive any so called 'sterilizing process' which aims at the destruction of bacteria while preserving the desirable physical properties of catgut. This study therefore concerns itself solely with the pathogenic spore forming anaerobes in raw catgut.

#### METHODS EMPLOYED

1. *Anaerobic conditions* Adequate anaerobiosis was obtained by the use of a modification of the McIntosh and Fildes anaerobic jar (6) which utilizes the direct reduction of oxygen by hydrogen gas. This jar permits both mass culture in fluids and colony culture on plates and the method is therefore preferable to test tube cultures with xaseline or other seal.

2. *Media* For surface colonies 10 per cent sheep's blood agar in Petri plates was used. Fluid media consisted in a modification of Hölman's (3) cooked meat medium containing salt and peptone with or without 0.2 per cent dextrose. For fermentation tests 1 per cent dextrose lactose saccharose salicin and mannite and 2 per cent glycine were employed. Litmus milk and Loeffler's serum medium served to indicate proteolysis. The media were adjusted to pH 7.4–7.6 with certain variations for special purposes.

3. *Material* Specimens of raw catgut were obtained from several of the manufacturing firms. One of them obtained samples from various sections of the United States and Europe. Upon its arrival in the laboratory the container was opened with sterile precautions in a dust proof room in order to obviate laboratory contaminations. The catgut was then placed in sterile test tubes and sealed.

4. *Inoculations* Meat medium was used for the primary cultures. Several strands of catgut were transferred from their sealed tubes to duplicate tubes of meat medium. One set was then incubated in the anaerobic jar for 24 hours. The other set was left in the incubator without opening the jar for 7 days.

5. *Isolation of species* After incubation for 1 or 7 days 0.5 cubic centimeters of the culture was transferred to each of three fresh test tubes of media. These were then heated in water baths for 15 minutes at 70 degrees C, 80 degrees C, and 90 degrees C respectively. The heated cultures were incubated and later plated. Colonies were then fished and replated until pure strains were procured.

6. *Determination of pathogenicity* The original heated cultures (which generally contained several species of spore forming organisms), as well as the pure cultures were used for inoculation in both mice and guinea pigs. Usually 0.5 cubic centimeter was injected into the muscles of the back or thigh. All animals which died were autopsied and cultures made from the tissues at the site of injection from the peritoneum and from the heart. If mixed cultures were obtained they were purified by repeated fishing and plating.

7. *The classification of pathogenic strains* This was finally accomplished by (a) studying the morphology of plate and fluid cultures (b) observing the lesion produced in animals by whole cultures centrifuged supernatant fluids and filtrates (c) analyzing the behavior of the strain in fermentation tubes with various carbohydrates (d) neutralizing the lethal action of centrifuged supernatant fluids and culture filtrates with known antitoxic sera.

#### RESULTS

Eighty three specimens of raw catgut furnished by six different supply houses were examined as completely as possible for pathogenic spore forming anaerobes. Some of these specimens had come from the stock yards within 2 or 3 weeks, others were at least 2 years old. There was no apparent difference between these two groups. Of the 83 specimens 45 yielded no pathogenic spore forming anaerobes. In the other 38 specimens 42 pathogenic spore formers were found. 4 of the specimens yielding two different species. There were 28 strains of hemolytic *Clostridium welchii* (*Bacillus aerogenes capsulatus* of Welch), 11 strains of non hemolytic *Clostridium welchii*, 4 strains of *Clostridium novyi* (*Bacillus oedematiens*) and one strain of *Clostridium oedematis maligni* (*Vibrio septique*).

We did not find *Clostridium oedematoide* (*Bacillus sordellii*) *Clostridium histolyticum* *Clostridium tetani* nor any virulent *Clostridium sporogenes*. We therefore took 38 more specimens and searched solely for these organisms but could not find them. Four cultures showed round end spores but were not toxin formers either in pure or in mixed cultures.

Two of the mixed cultures produced necrosis of skin and subcutaneous tissue without death of the animal. When the organisms contained in this mixture were isolated and injected in pure culture they did not have this effect. These mixtures did not include *Clostridium histolyticum* and the necrotic lesion did not resemble the lesion produced by *Clostridium histolyticum*.

Six of the mixed cultures which failed to kill in the usual dosage were concentrated by centrifuging so that 8 cubic centimeters was reduced to 0.5 cubic centimeter. This thick suspension was then injected in the usual way. Two of these six cultures produced death but when these mixtures were separated pure cultures of the organisms contained in the mixture concentrated in the same way failed to kill.

Only one of the cultures incubated for 7 days yielded a pathogenic organism which was not recovered from the 24 hour culture. This proved to be *Clostridium novyi* (*Bacillus oedematiens*).

firms that employ the method. Then we must demonstrate to the makers that without any compromise on efficiency it is the most practical method yet devised. We thought of the possibility of attempting to get legislation passed similar to the pure food regulations, but it was obvious at once that this would entail considerable difficulty both in the passage and the enforcement of such a law. On the other hand, the existence of the Hospital Standardization Committee of the American College of Surgeons presented at once a mechanism which would not only initiate the regulations but see that they were consistently and perpetually carried out. An endorsement by the Hospital Standardization Committee of the American College of Surgeons of the products of only those firms who submitted their catgut to this test would rapidly eliminate by disuse those firms which were not willing to yield to this final check up of their goods.

A consideration of the problem had reached this stage when, entirely without solicitation, but greatly to my gratification, one of the larger catgut firms approached the writer with an offer to finance the study of this problem. It was felt, however, that inasmuch as it was a question of vital interest to other firms, it would be better to enlist the interest of several so that it would be evident to the profession and to the firms as well that it was an unbiased study, not favoring the product or the methods of any one firm.

A plan for the study was outlined a year ago and received the approval of the committee on hospital standards of the American College of Surgeons, and the support of four of the larger catgut firms. First it seemed necessary to determine just what organisms we had to deal with. This entailed a review of anaerobic bacteriology and a study of the bacteria occurring in raw catgut. Second, the cultural characteristics of the organisms found in pure and mixed culture should be studied to determine their thermal and chemical death points, their optimum medium, the optimum reaction for the medium, the decrease of oxygen tension required for growth, the length of time required to germinate long hidden spores, the synergisms and antagonisms of these organisms, and their patho-

genicity for laboratory animals. Third, a general survey should be made of the methods now being used by the various catgut firms to see if the organisms found in raw catgut could be made to grow by these methods even when planted in high dilution or after prolonged storage. Fourth, a chemical study should be made of the antiseptic storing fluids, their inhibitory effects on the bacteria present in raw catgut and various methods devised for neutralizing their effects. Finally, a method would have to be worked out, possibly combining the best features of methods already in use, or a brand new method, but one which would make certain the growth of any living organism present in catgut, no matter how few they were in number. The method would have to be 100 per cent efficient, first of all, and simple enough to be practical for large numbers of specimens to be tested at one time.

The Hospital Standardization Committee of the American College of Surgeons promised that if the results of this study were entirely satisfactory they would recommend the products of only those firms which were willing to subject their goods to this test, not occasionally but with specimens from every single sterilized batch of material. It was felt that all of the reputable firms would be willing to follow the lead in the matter and adopt the standard test and any firms which did not fall into line would find no market for their goods. If hospitals and doctors the country over then followed the advice of the committee they could buy catgut with perfect confidence and perfect security, and the risk of fatal accidents such as I have described would be reduced to a minimum. There would have to be a constant check up by the committee to see that the test was followed strictly and the name of any firm not complying would have to be immediately removed from the list of accredited firms.

The plan thus outlined has been partially carried out and will be completed during the present school year. The progress made so far seemed to the committee to be sufficiently satisfactory to be presented at this meeting to arouse your interest and to enlist your cooperation so that when the work is done it

which require the strictest anaerobic environment and sufficiently long incubation time must be given for them to make themselves manifest

## REFERENCES

- 1 BREWER G E, and MELENEY F L. Progressive gangrenous infection of the skin and subcutaneous tissues following operation for acute perforative appendicitis: a study in symbiosis. *Ann Surg*, 19 6 xxxiv, 438-450
- 2 CASTELLANI A. Importance of symbiosis or close association of different species of organism. *J Am M Ass* 1926 xxxvii 15-22
- 3 HOLMAN W L. The value of a cooked meat medium for routine and special bacteriology. *J Bacteriol* 1919 14, 149-155

- 4 HOLMAN W L and MEEKISON D M. Gas production by bacterial synergism. *J Infect Dis*, 1926 xxxix 145-171
- 5 HUMPHREYS F and MELENEY F L. The identity of *C. oedematoides* and *B. sordelli*. *Proc Soc Exper Biol & Med*, 1928, xxv 611-614
- 6 MCINTOSH J, and FIELDS P. A new apparatus for the isolation and cultivation of anaerobic micro-organisms. *Lancet Lond*, 1916 1 763-770
- 7 MELENEY F L, HUMPHREYS F B and CARP, L. An unusual fatal operative wound infection yielding a pathogenic anaerobe of the gas gangrene group. *Surg Gynec & Obst* 1927 xlv, 775-789
- 8 MELENEY F L. Aerobic and anaerobic examples of hemolytic bacterial synergism. *Proc Soc Exper Biol & Med* 1928 xxv 205-206
- 9 TEN BROECK C and BAUJA J H. The tetanus bacillus as an intestinal saprophyte in man. *J Exper Med*, 1922, xxxiv 261-271

## DISCUSSION OF PAPERS BY IRVING J WALKER AND FRANK L MELENEY

DR SUMNER L KOCH Chicago It is a privilege to be asked to discuss the papers to which you have just listened. The effort to prevent contamination of surgical wounds by preventing bacteria from passing from the noses and throats of those in the operating room into open wounds and the attempt to render surgical catgut absolutely sterile command the interest and deserve the co operation of every one concerned with the practice of surgery.

Some few years ago Dr Meleney<sup>1</sup> was able to follow the course of a series of postoperative wound infections and to identify the causative streptococcus as identical with a strain obtained from the nose of one of the operating room nurses. He showed further that 33 per cent of the operating room staff harbored hemolytic streptococci in their throats and subsequently,<sup>2</sup> that there is a seasonal rise in the incidence of streptococci in the throats of healthy individuals which reaches its height in the later winter months and recedes with the approach of summer.

That there are fatalities occurring every year from streptococcus infections due to contamination of surgical wounds in the operating room none of us doubts. In 1926 I saw two such cases which made an ineffaceable impression on my memory. One patient was a young woman 22 years of age with a hemolytic icterus. Her father had had a hemolytic icterus of years duration and had been cured by splenectomy. Because of the successful result in the case of the father a similar operation was performed upon the daughter early in March 1926. Eighteen hours after operation at four o'clock in the morning I was called to see the patient. She had a temperature of 104.6 degrees a pulse of 160 and was becoming delirious. She was given fluids intravenously, heart stimulants and repeated cool sponges but she died 48 hours after operation. Autopsy showed a generalized peritonitis due to a virulent hemolytic streptococcus.

<sup>1</sup>Surg Gynec. & Obst. 1926 xlii 338

<sup>2</sup>J Am M Ass. 1927 lxxvii 1302

A week later a man with an exophthalmic goiter was operated upon. Bilateral ligation of the superior thyroid arteries was performed under nitrous oxide anesthesia. Within 48 hours he was dead from a hemolytic streptococcus infection.

No more operations were performed on our service for three weeks. On April first the internes changed services. Almost within a week a death from peritonitis occurred on the gynecological service 48 hours after operation on a clean case. Looking back over this series of events we remembered that the senior interne on our service had been in bed during the last week in February with an acute tonsillitis. He was very anxious to get back to work and assisted in the first two cases mentioned. April first he was transferred to the gynecological service and death occurred in one of the first cases in which he assisted. He was then sent away from the hospital for 6 weeks and no more similar catastrophes occurred.

Doubtless similar cases have occurred and are occurring elsewhere. Rarely are they reported or traced to their source. Of eminent practical importance is the fact stated by Dr Meleney in the paper quoted above that after the noses and throats of all the operating room personnel were masked there were no more hemolytic streptococcus infections in clean cases. The mask which Dr Walker has described is, he feels the most satisfactory it has been possible to devise. We owe it to our patients and ourselves to give it a thorough trial.

Of equal importance to protecting patients from infection from carriers of pathogenic organisms is it to assure the sterility of catgut. You are familiar with the report of Dr Meleney upon a small group of cases of wound infection due to an unusual type of gas producing organism found in the catgut used.

Two years ago a woman of 50 on our service was operated on for hyperthyroidism. On the fifth postoperative day she complained of a headache.

Three of the seven day mixed cultures produced almost instantaneous death when injected either as a whole culture or as a centrifuged supernatant fluid. When the organisms contained in this lethal mixture were isolated and injected in pure culture they produced no visible effect whatsoever.

Almost all of the animals which died following injection succumbed in 24 hours. A few strains of bacillus welchii killed in 48 hours. When 0.5 cubic centimeter of a culture killed a mouse the same dose was sufficient to kill a guinea pig.

Three strains which morphologically and culturally resembled vibrio septique were found which were non pathogenic.

The pure strains of pathogenic spore forming anaerobes found in these specimens of raw catgut have been studied to determine the optimum medium for growth, the optimum hydrogen ion concentration, and the optimum degree of anaerobiosis. The anaerobic jar and the cooked meat medium are not ideal for large numbers of tests such as would have to be done by a large catgut firm. A clear medium with a vaseline seal is to be preferred. The results of this phase of the study will be published in the final report.

At first glance one is perhaps surprised that less than half of the specimens contained pathogenic spore forming anaerobes and that all of the known species were not found. It should be remembered however, that we are dealing with the upper third of the intestine. It is well known that this contains fewer organisms than the lower portions. Aerobes were present in all of the specimens. We frequently found those heat resistant streptococci which will survive 70 degrees C for 15 minutes. Non pathogenic heat resistant spore formers were present in almost all of the specimens. It should be emphasized that we do not claim to have recovered all of the pathogenic anaerobes which were present in the catgut specimens. It is quite probable that in mixed cultures pathogenic strains were inhibited or overgrown by the non pathogenic strains and in plating they may have been invisible as separate colonies. At times single colonies transplanted to other plates or to broth failed to grow. This is a fairly common thing with such strict anaerobes as *Clostridium novyi* (bacillus oedematis). It is possible that a few pathogenic anaerobes were lost on that account.

It is not surprising that *Clostridium welchii* so far outnumbered the other pathogenic anaerobes. This is consistent with the general distribution of the organism and the usual proportion of these different species in cases of gas gangrene.

The absence of true tetanus bacilli was of interest. Although after prolonged incubation four cultures yielded round end spores they did not make toxin. Ten Broeck and Bauer (9) in their study of the incidence of tetanus in the stools of Chinese patients, brought out the fact that in mixed culture the tetanus bacillus often does not produce toxin. They also state that in a large series of cultures containing organisms resembling tetanus bacilli only one failed

to yield toxin when the strain was purified. We are confident that we purified our cultures and still failed to find any true tetanus bacilli. This does not mean that this organism or any of the other anaerobes which we failed to find were certainly absent in the specimens or would be absent from another hundred specimens.

We consider it to be of unusual interest and importance that mixed cultures produced certain effects such as necrosis of skin, sudden death or gradual death, while the individual species comprising the mixture were non pathogenic in pure culture. We believe that this illustrates the general principle of the adjuvant effects of species in symbiosis, sometimes called synergism which has been demonstrated in a number of ways (1, 2, 4, 8).

The appearance of a pathogenic anaerobe (*Clostridium novyi*) in the 7 day culture which failed to appear in 24 hours shows the necessity for prolonged incubation. Any test which is devised to determine the sterility of catgut which has gone through some sterilizing process must take this into account.

#### SUMMARY

1. Eighty three specimens of raw surgical catgut have been studied to determine the presence of pathogenic anaerobes. Thirty eight of these specimens were found to contain these organisms.

2. The 38 positive specimens yielded 42 strains of pathogenic spore forming anaerobes comprising all of the three common species of gas gangrene organisms. There were 13 strains of hemolytic *Clostridium welchii*, 21 strains of non hemolytic *Clostridium welchii*, 2 strains of *Clostridium novyi* and 1 strain of *Clostridium oedematis maligni*.

3. Thirty eight other specimens were examined specifically for the other known pathogenic spore forming anaerobes, namely *Clostridium tetani*, *Clostridium oedematis* (bacillus ordellii) and *Clostridium histolyticum*, but these species were not found.

4. Certain of the non pathogenic species of organisms produced destructive lesions or lethal effect when injected in mixed culture which they could not produce in pure culture, thus illustrating the general principle of symbiosis or synergism.

5. Prolonged incubation for 7 days brought to light a pathogenic anaerobe which did not appear in the 24 hour culture.

#### CONCLUSIONS

In considering any sterilizing process to be applied to catgut it must be assumed that any or all of the well known gas gangrene spore forming anaerobes are present in the material.

Any test to determine the sterility of the final product after it has passed through the sterilizing process must be able to bring to light any organism which may be present. The media and the method must be favorable to cultivate those anaerobes

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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JANUARY 1930

### NINETEENTH ANNUAL CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

CHICAGO had not been host to the Clinical Congress since 1923 and every effort was exerted to make this year's meeting a homecoming event that would long be remembered. The Chicago Committee on Arrangements took advantage of its opportunity to utilize the extensive clinical facilities of the city and a widely varied and extremely interesting program was the result. More than three thousand surgeons from all parts of the United States, Canada, and foreign lands spent 5 busy days attending the numerous clinics and demonstrations. The evenings between the Presidential Meeting on Monday and the Convocation on Friday were taken up with excellent well planned scientific meetings.

The program of clinics prepared by the subcommittee on surgery of the eye, ear, nose and throat was all that could be desired and the attendance at these clinics indicated the great interest in these surgical specialties. On Wednesday evening, October 16, a dinner meeting

for this group was held at the Hotel Stevens with Mr. Herbert Tilley of London as the principal speaker.

The progress of the medical motion picture department of the College was clearly shown by the exhibition of films that have been completed under the supervision of, and have been approved by, the Board on Medical Motion Picture Films. In addition to the films produced under supervision of the College, a number of other films of unusual merit or interest were shown, including several reels of colored film and four talking films.

The annual hospital conference proved to be another outstanding feature of the Congress. Emphasis was placed upon "the care of the patient" in this year's conference and a series of interesting and instructive demonstrations, papers, and round table conferences was included in the program. An added feature of the hospital program was the joint session held with the Association of Record Librarians of North America. This organization was formed last year at the Congress in Boston and has already proved itself an aid in overcoming the difficulties all hospitals have in trying to improve their records.

The entire day of October 18 was spent on the discussion of traumatic surgery. An open forum and symposium were held in which representatives of labor, indemnity organizations, industrial concerns, and surgeons interested in that phase of surgery participated. A gratifying amount of interest was shown in this conference.

Reports of officers and standing committees of the College were presented at the annual meeting of the Governors and Fellows held on



Aspirin and pyramidon were given, but the headache persisted and she began to complain of difficulty in swallowing. We were concerned but thought that inflammatory reaction about the œsophagus might explain the symptoms. The same evening she complained of tingling of the hands. One of our best medical men examined her carefully. The question of tetanus was brought up but we concluded that she was probably suffering from a mild tetany, and began administration of calcium and parathyroid extract. The following morning she developed for the first time difficulty in opening her mouth, and immediately antitetanic serum was given intraspinally and intravenously. In spite of the serum the patient rapidly became worse and died within 24 hours with the characteristic symptoms of tetanus infection. I have seen two other cases that developed the clinical picture of tetanus, one 12 days after a herniotomy the other 3 weeks after a pelvic operation. Fortunately both of them recovered. It is not

necessary to say that any effort which promises to make impossible surgical tragedies of this type deserves our whole hearted admiration and support.

We are greatly indebted to Dr. Walker and Dr. Meleney for the work they have done. It is a fortunate circumstance that men who possess the essential combination of an extensive experience in clinical surgery and years of training in bacteriology are devoting themselves to the solution of these problems.

It is also a matter of congratulation that the College of Surgeons is having a part in this work—not simply because we as members of the College have a personal interest in its activities but because it is always a matter of congratulation when a body of individuals united for the common good can by education by example and by moral force help to bring about far reaching improvements such as Dr. Meleney has indicated the manufacturers of catgut are voluntarily about to undertake.

the rich wisdom of Wilkie's paper and the impressive results that are being obtained in the treatment of pelvic cancer by Heyman and his associates at the Radiumhemmet

SUMNER L KOCH

## THE CLINICS OF THE CONGRESS

**I**N no other profession do the members display such gregarious tendencies as do those in medicine and surgery. It is rightly so, since the education of the doctor is a life long business. The problems of disease are complicated, difficult, individual, and uncertain. The lawyer has the forms, procedures, and precedent of laws which have been laid down during the years. The minister, once having grasped the certainties of divinity, may settle himself into a life of delight and pleasure.

Our medical schools see to the educational requirements of the medical student but the further education of the doctor is self imposed. No other method of medical graduate education is so widely employed as that of attendance upon medical gatherings of one sort or another. We may read of a newly discovered scientific fact, or an improved bit of surgical technique but the interest so aroused is not comparable to that awakened when the same fact is given to us as a personal offering.

It is not difficult then to understand why the clinics given during the week's meeting of the Clinical Congress of the American College of Surgeons have met with such success from the time of the first meeting in 1913. During such clinics each year some three to four thousand surgeons are given the opportunity to see their colleagues at work in their various hospital and medical school homes throughout the country. There is a stimulation of interests and there is an exchange of ideas and methods which are of mutual advantage. The

individual patient and, therefore, the public are the ultimate recipients of the benefits of such clinical gatherings.

The clinics given by the members of the medical profession of Chicago during the recent Congress maintained the high standards which had been set in previous years by men in other cities. Every field of interest in surgery was represented in these clinics. The attendance was large and, as usual, efficiently distributed by the management of the Congress. This is worthy of more than passing notice, when it is realized that the choice of attendance upon a given clinic rests with each individual surgeon who attends.

The enthusiasm to make these clinics successful which was shown by the doctors of Chicago, many of whose interests lie outside of surgery, is a tribute to the spirit of progress in that continuous march of self education which is the outstanding characteristic of the medical profession.

LOYAL DAVIS

## THE HOSPITAL AND SURGICAL PRACTICE

**T**HE trend of medical practice today is very clearly shown by the relationship existing between the medical profession and the hospitals. Having developed through the past years into the present admirable institutions so highly professional in character, hospitals have attained a position of great importance. They are no longer mere shelters or asylums or even workshops but are functioning factors of significance in the care of the sick and injured and must be accorded that place in the practice of the art of medicine. Great responsibility is now given to the various hospital workers whose education and training in specific scientific fields have earned the confidence and esteem of the medical profession. Today, the physicians and the hos-

October 17 In addition to the reports, officers were elected for the ensuing year Following the annual meeting a symposium on cancer was presented

The various committees and boards of the College held meetings, reported on progress made, and discussed plans for furthering the work in 1930

At the Convocation on Friday evening, October 18, the 1929 class of Candidates for Fellowship was admitted to the College This group numbered 669

Distinguished members of the surgical profession from other lands were in attendance at the Chicago Clinical Congress Some came to participate in the program of the Congress and others were spectators Among these visitors from abroad were the following Florestan Aguilar, El Vizconde de Casa Aguilar, M D, Madrid, Spain, Harry Harris, M D, Ch M, F C S A, Sydney, Australia, James Heyman, M D, Stockholm, Sweden, J Newman Morris, B S, M B, F A C S, Melbourne, Australia, W A Osborne, M B, B Ch, D Sc, Melbourne, Australia, Herbert Tilley, M D, B S, F R C S (Eng), London, England, Henry S Wellcome, LL D, F S A, London, England, Daniel M Velez, M D, F A C S, Mexico City, Mexico, and D P D Wilkie, M B, Ch B, M D, F R C S (Eng and Edin), M Ch, F R S (Edin), F A C S, Edinburgh, Scotland Honorary Fellowships were conferred upon Florestan Aguilar, James Heyman, and W A Osborne

DAVID C MACKIE

## THE SCIENTIFIC PROGRAMS

A BRIEF survey of the scientific programs of the recent Clinical Congress discloses a number of interesting facts a large part of one of the four evening sessions was devoted to a subject—pernicious

anæmia—ordinarily considered as of interest only to medical men, four papers—Archibald's Walters', Walker's, and Meleney's were devoted essentially to the question of placing greater safeguards about surgical patients and rendering surgical procedures less hazardous Only two papers—Holden's and Harris'—were primarily concerned with the question of surgical treatment, only one paper—Adson and Rowntree's—was devoted to the presentation of a newly developed method of surgical treatment, and this paper was discussed, not by surgeons, but by a neurologist and a neuro anatomist, of thirteen others who took part in the discussion of the papers presented, two were physiologists and one a specialist in internal medicine These facts seem to us to indicate the means by which American surgery is attempting to advance—by seeking closer contact with the departments of internal medicine, of physiology, of anatomy and bio chemistry, by turning to the experimental laboratory, as Dragstedt emphasized in his discussion upon intestinal obstruction, by asking the bacteriologist to help find the sources of wound infection and to devise means of making cat gut absolutely sterile

That American surgery continually holds out its hands across the seas and says "Come over and help us," and that the response is always a generous one is evidenced by the roll of distinguished surgeons from the Continent, from Britain and from the British Commonwealths that have contributed so largely to the Clinical Congresses of this and of former years The Murphy Oration of Professor Wilkie and the paper of Dr Heyman upon the treatment of cancer of the pelvic organs were highlights in a series of interesting and stimulating programs Those who had the privilege of hearing them will appreciate still more in the quiet of the library

ing whom the College has honored itself. Finally came the distinguished guests, representing many nations and many fields of endeavor but bound by a common bond of honorable achievement, and behind them were seated the Governors of the College.

After the playing of the music common to "God Save the King" and "My Country, 'Tis of Thee," the invocation was offered by Dr. John Timothy Stone. The Director General then presented 669 candidates, the majority of them present, who were formally received into fellowship by the President. The candidates for honorary fellowship were then presented by Dr. Irvin Abell, by Dr. Allen B. Kanavel of the Board of Regents and by Dr. C. Jeff Miller, president elect. The "Presidential Address" by Surgeon General Ireland and the "Fellowship Address" by Dr. Glenn Frank, president of the University of Wisconsin, together with the remarks of the Director General, will be found in full elsewhere in this volume (see pages 296, 302, 285 and 295). They speak for themselves. I cannot, however, refrain from commenting on their high level of excellence, or from commending to the par-

ticular attention of the Fellows of the College President Frank's admirable and well considered statement of the responsibility of the profession for the health of the nation and his grave warning that unless we set our own house in order, control of medicine by the state is the inevitable consequence.

The playing of "The Star Spangled Banner" and the recessional march from the platform brought to a close the Convocation of 1929, and I, who have seen many Convocations of the American College of Surgeons, was stirred as I always am by what this organization is and what it stands for. Certainly there can be few ceremonies more beautiful to behold, more replete with significance, than this solemn ritual by which a great surgical brotherhood sets its seal of approval on the neophytes who have sought admission to its ranks. In its simple dignity, in its deep meaning, in its solemn pledge, in its note of consecration, it is a ceremony which touches alike the hearts of the new Fellows and of Fellows grown gray in its service and which reminds them anew of the sacredness of the task entrusted to the surgeons of America.

C. JEFF MILLER

hospital personnel labor side by side as associates even though the former directs and bears the major responsibility

The American College of Surgeons for several years has recognized this co ordination of effort by arranging and providing for Hospital Standardization Conferences, in conjunction with the meeting of the Clinical Congress. The programs are formal and informal, and surgeons, hospital authorities, nurses, and others contribute to discussions of mutual problems. These conferences are unique, outstanding and significant, since they offer opportunity for the surgeon and the hospital worker to exchange opinions and constructively to analyze future activities and determine procedures

During the recent four day meeting students of medical affairs were gratified by the earnest and intelligent presentations of valuable contributions by eminent surgeons and well known hospital representatives. Through formal papers, open forums, and general discussions many of the perplexing and unsolved problems received serious attention and helpful suggestions

The opening session was devoted to a symposium on the timely subject of the cost of medical care. The comprehensive program included spokesmen of the several factors concerned and was productive of seasonable pertinent comments and contributions of real worth pertaining to the subject. Some of the other topics of general interest presented were the accrediting of surgical deaths, the lessening of surgical infections and complications due to errors in technique and the use of unsafe material, measures of efficiency and proper requirements for the ideal functioning of important hospital activities and departments. These and the other equally opportune themes discussed are indicative of the sane methodical endeavor on the part of serious minded

physicians and their hospital collaborators to meet their responsibilities. F. H. SLATON

## SEVENTEENTH CONVOCATION

THE seventeenth convocation of the American College of Surgeons was held the night of October 18, 1919 in the Grand Ballroom of the Hotel Stevens in Chicago, the beautiful appointments and dignified spaciousness of which made it a fit setting for such a ceremony. Blazing with lights and hung with flags, it was crowded to the doors and to the very edges of the galleries long before the candidates for fellowship in the robes of the College, filed into their seats immediately below the platform.

Then to the strains of martial music the stately procession of College dignitaries and honored guests made its way down the central aisle to the seats on the stage. At their head a captain of the United States Army bore the Great Mace of the College, the gift of the consulting surgeons of the Armies of Great Britain, in token of undying friendship and in lasting memory of those days of trial when the two great English speaking nations of the world fought shoulder to shoulder that freedom should not perish from the earth.

Then in blue and scarlet gowns and caps, came the officers of the College. Dr. Franklin H. Martin, director general and past president to whose inspired thought this noble organization owes its conception and existence, Surgeon General Merritte W. Ireland, president, Dr. C. Jeff Miller, president elect, other officers and officers elect, and members of the Board of Regents. After them came the candidates for honorary fellowship: Alvaro Aguilar of Madrid, Professor James Heyman of Stockholm, and Professor William Alexander Osborne of Melbourne, men of eminence literally from the Antipodes, in honor



*Franklin H. Marlen*

# PRESIDENTIAL MEETING AND CONVOCATION

## ADDRESS OF WELCOME<sup>1</sup>

HEKMAN L. KRETSCHMER M.D., F.A.C.S. CHICAGO  
Chairman Chicago Committee on Arrangements

IT is indeed a great honor and a rare privilege to welcome you to Chicago to attend this the nineteenth annual meeting of the Clinical Congress of Surgeons of North America. This I do on the behalf of the College, its officers, and workers who have so faithfully and with a great deal of enthusiasm and much hard work arranged this meeting for you and also on behalf of the men who will conduct the clinics during this week, as well as on behalf of the hospital authorities and personnel who have so generously and with such fine spirit co-operated in arranging the clinical part of the program.

The local men are delighted to have the opportunity of taking part in the program and to be given the privilege of seeing so many of you here and the chance to renew old friendships and acquaintances.

It has been 6 years since the Congress met here. Since that meeting a great medical expansion has taken place. Some of the hospitals have built elaborate additions, others have replaced the old with new buildings, and many new hospitals have made their appearance. This hospital expansion allows us to boast of the largest hospital in the world, namely Cook County Hospital with a total bed capacity of 3,300.

Beside these great strides in hospital development two new medical schools have been built and put into operation: the Medical School of the University of Chicago on the Midway and the splendid unit of the Northwestern University on the McKinlock Campus.

May I burden you for just a few moments to direct your attention to some of the other medical activities located here that have contributed so much toward the medical development of Chicago? This is the home of the American Medical Association, the largest medical society in the world, which publishes the *Journal of the Amer-*

*ican Medical Association*, having the largest circulation of any medical journal in the world.

The home of The American College of Surgeons is also located in Chicago. The great accomplishments of the College are directly due to the vision and stimulation of the founder, our present president. Its modest beginning stands in marked contrast to its manifold activities today and each year many new activities are undertaken.

The office of the largest surgical journal published in the world is located in Chicago, and we are all proud that this is the official journal of the Clinical Congress.

We can now boast of six great medical libraries, namely, the John Crerar, the Library of The American College of Surgeons, the splendid library of Rush Medical College, the Billings Library, Quine Library, and the Archibald Church Library.

There are many other closely allied medical institutions. The home of the American Hospital Association is located here, and here are published two great journals dealing with hospitals, namely, *The Modern Hospital* and *Hospital Management*.

More and more as time goes on the close relationship between dentistry and medicine becomes apparent. We find here the greatest dental organization, the American Dental Association, which publishes the greatest dental journal in the world.

All of these facilities, ladies and gentlemen, we place at your disposal in the hope that your attendance at this Congress may be a profitable as well as an enjoyable one.

And finally, before closing may I pay a brief tribute to those surgical pioneers who have done so much for American surgery, locally, nationally, and internationally? It seems to me that at this time it is only fitting that we do this. In passing may I mention Senn, Murphy, Gunn, Isham, Fenger, Ochsner, Parks, Edmund Andrews, E. Wyllis Andrews, Graham, Ferguson.

<sup>1</sup>Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 24, 1929.

ADDRESS OF THE RETIRING PRESIDENT<sup>1</sup>

FRANKLIN H MARTIN M D F A C S CHICAGO

**S**URROUNDING me here are my associates with whom I have worked for twenty four eventful years. For twenty three years I acted as a sort of chief gardener in the cultivation of the soil, I did the footwork under their sympathetic guidance. Last year they honored me with the presidency of this organization.

## A PARABLE

## I

In 1905 with Nicholas Senn, John B. Murphy, William J. Mayo, and George W. Crile, we selected a field and with seriousness sowed the seed upon it. It was a literary seed.

Our critics laughed, and asked "How do you practicing surgeons expect to grow a successful crop of surgical journalism when real literary genius is reaping only a scant harvest?"

That is the point! we brusquely answered. 'We are sowing a seed created from the yearnings of practical surgeons who not only write of surgery but who actually do it and we hope to reap a magazine that will interest, inspire, and instruct other practical surgeons like ourselves.'

So the gardener, stimulated by such encouragement, put hoes into the hands of loyal young diggers—Kanel, Besley, Cubbins, Hollister, and Ballou—and an unexpected crop resulted. It was so lusty, so thriving and so worth while that they gave it the euphonious name of SURGERY, GYNCOLOGY AND ONSTETRICS—fondly nicknamed by the vulgar S G & O.

## II

Rapidly the crop developed into a grove of rugged trees. Each leaf of these trees represented a message from a practical surgeon. Each was a message to the head gardener which said 'Congratulations! Enlarge your garden. We are impressed with the practical writings of your editors. Let us see them in action.'

So we planned the new field and hoed and watered and lo! other helpers joined us. Ochsner, Cotton, Edward Martin, Brewer, Charles Mayo, Squier, Eagleson, Clark, Porter, Matas and Lund. And the crop was overwhelming. The new apparition when it came in 1910 was called the Clinical Congress of Surgeons of North America.

This crop brought practical men into their own. They would now be shown. Each twig on the

tree of practical literature brought with it another yearning brother, and there were some crowds in the great cities that received and welcomed the new idea.

## III

The soil that brings forth an abundance of wheat also attracts and develops tares and thistles. The gardener and his proud workers were becoming panic-stricken. The fertile field, without exclusive walls, with the wind and the sunlight stimulating its crop, did not discriminate. The gardener and his aids pondered and declared that the obstructing weeds must be destroyed. The tares of ignorance and effrontery, and the thistles of unethical commercialism must be torn up and cast aside.

A new sowing must be planned with a careful sifting of the seed. The work of years must be conserved inviolate. The ideals must be established in permanency.

The workers, trained in a common service during 8 long years, put their heads together and determinedly considered the existing facts. Many serious followers had become their willing aids. In the hopper of their conference they placed their practical accomplishments, their ideals of fair play and intellectual worth, and their many plans for conservation. The tried workers sharpened their weapons, re-examined their soil, segregated their seeds, and with their combined experience replanted. The unfenced field again brought forth, under the surveillance of these experienced laborers, a new, an abundant, and a pure grade product. The sifting of the seed had accomplished much. It was realized that watchfulness of the growing crop was necessary if surreptitious tares and thistles were to be eliminated.

Thus in 1913 the gardener and his followers looked upon the crop, and it was good. They called it the American College of Surgeons.

The conventionalists and the traditionalists critically observed this new crop shrugged their shoulders, and complimented its creators by pronouncing it 'too good to last.'

England sent its distinguished President of the Royal College of Surgeons, Sir Rickman Godlee, the nephew of Lord Lister, to grace the first Convocation. He did not shrug his shoulders but looked upon the new venture with sympathy and approval.

<sup>1</sup>Presented before the Clinical Congress of the American College of Surgeons, Chicago, October 24-28, 1919.





Fifth conduct a practical research into the records and treatment of cancer—the clinic and hospital services of our nine thousand Fellows and our two thousand accepted hospitals to be used as an amplified laboratory from which the consensus of experience and opinion may be gathered and a yearly pronouncement formulated as to the best treatment for this dread disease.

Sixth, aid industry to perfect an organization to standardize its medical methods and to provide medical and surgical care to sick and particularly to injured employees in such a manner as to insure efficient work by the surgeon to earn the approval of officials of labor to meet the requirements of indemnity laws and to warrant satisfaction in the underlying industries.

Seventh promote the Clinical Congress, the first large organized society of clinical surgeons and the forerunner of the College and continue to provide through the Congress clinical meetings in the large cities at which the attending surgeons may witness practical demonstrations in surgery and observe the actual technique of operations.

This then gives a bird's eye view of your organization, the American College of Surgeons. Ours is a practical program. Through the judicious management of our funds we have enlisted the support of our large fellowship who themselves finance our progressive activities with a yearly budget that has varied during the years until now it approximates two hundred thousand dollars.

The citizens of Chicago and the local Fellows gave to the College its headquarters in this city; the friends and family of Dr. John B. Murphy built and gave to the College the Murphy Memorial Hall and Library and the College has recently financed the purchase of an additional one quarter block which adjoins the present home and on which will be built our Clinical Research Museum.

The program of the College, in its varied activities has been accorded enthusiastic reception. Our strict requirements for Fellowship—with the elaborate machinery of educational and professional references, state committees on credentials and the final test of case records—are looked upon as professional hurdles that every aspiring surgeon should be able to negotiate successfully.

The program of hospital betterment which has been accepted by the hospital world of this continent creates a tragedy for the institution that does not meet the requirements of the Minimum Standard of the College. The profession requires the standard; the people have learned to look for the certificate of approval; the university medical schools make it their requirement for the assign-

ment of internes, and the government hospitals have recognized the College's survey and require its approval.

For 9 years the College has carried on research in the treatment of cancer (carcinoma and sarcoma). Its findings represent the work of hundreds of our members who report their cases to the heads of our two committees. These valuable findings are becoming more and more valuable as successive five year cures are recorded. Two years ago at the Conference of the British Empire Cancer Campaign in London, every address which dealt with sarcoma spoke of the College's Registry. Its comprehensive archives of cancer will make its work of lasting importance. The Committee on the Treatment of Bone Fractures has an important place in the Clinical Research Department. It was the outgrowth of the stimulus given to this important subject by the treatment of fractures in the World War.

Time will not permit me to dwell on the other important activities represented by our departments of Literary Research, Motion Pictures for Medical Teaching, the Standardization of Hospital Equipment and Instruments and the far reaching importance of our publications, including the official journal SURGERY, GYNECOLOGY AND OBSTETRICS.

When questionings arise, when criticisms threaten, when the gossipers embarrass, when our ideals are ridiculed, remember that we are but 9,000 in comparison with 160,000.

Remember that the tree with the most desirable fruit has beneath it the largest number of missiles.

Remember too, that the rank and file of us have the same responsibility in maintaining our ideals and standing as do those wheel horses who have borne the brunt of the fray from our earliest days.

From a small beginning we have built in a few years an institution of worth whose reputation has gone far and whose influence has extended to laymen and to the profession alike. Reputation will not last unless worth and influence are behind it. The development of academic complacency will soon displace strong convictions and thrift and enterprise if the wise among us are not constantly wakeful to its insinuations and if we do not have the courage to stamp out its earliest appearance. This will require constant thoughtfulness as well as watchfulness.

These fundamental principles are observed with religious enthusiasm by your inner group of associate administrators who as your working under studies conscientiously year by year, have carried out our intricate program. You have known each

From behind the traditional walls of Princeton and Johns Hopkins came John Finney, the first President, who surveyed the open field and quietly took off his coat and labored.

Following Finney, Crile became our chief, and added to our store his research mind and his mechanistic theory. Then, behold came William, who until that time had watched Charlie do the hoeing. *He was some cultivator himself.* He would show these amateurs! Off came his coat. He chose for his weapon a brand new axe. This for two long years he swung with vigor. Then came the giant of the North, Armstrong, who imparted dignity and loyalty, came Deaver, from Quaker town, with his pious gestures and his spectacular accomplishments! Reluctant Cushing, who thrice refused the crown as he critically surveyed from "precedent tower" of Harvard the unfenced field of "upstarts," finally succumbed to the persuasion of William and his axe became a lamb, donned the crown, and was an interested worker.

Then came beloved Ochsner with his battle-axe pledge against commercialism and bluster. He developed into the watch dog of our growing treasury, required as no other man the ideals of the College and after his labors was laid to rest at his own bidding, in the presidential robe of the American College of Surgeons. Wise and faithful Charlie was promoted from the ranks, followed by the pride of Dixie, Matas, who told us all about it, Clupman with his wisdom and eloquence and then George Stewart the wise Scot from Manhattan who charmed us with his wit and instructed us with his maxims of common sense.

The consulting surgeons of the Armies of Great Britain sent Sir Berkeley Moynihan to us with a golden mace, an ancient club of authority which added a touch of tradition to our brand newness.

And so our field has grown, and our jurisdiction has extended. At first Canada and the United States. How lucky that we fixed no boundary and that we did not exclude! Mexico, Central and South America are now among our workers. Australia and New Zealand applauded, asked for our co-operation and complimented by imitating us.

The Presidents of the Royal Colleges of England, of Ireland, and of Scotland have honored us by becoming our Fellows and have commended our progressive organization. Our fellowships are valued not only in the British Isles but in France, Spain, Italy, Norway, Sweden, Denmark, Holland, Belgium, Switzerland, India, China, Japan and Africa.

Thus readeth the parable

### THEN WHY THE AMERICAN COLLEGE OF SURGEONS?

There was need for a comprehensive democratic association of surgeons and surgical specialists, an association or guild to which all practical surgeons could aspire for fellowship, where moral and spiritual ideals could be openly discussed and affirmed, where education and professional ability would outrank effrontery, commercial trickery and social prestige.

Brave men risked the questioning and resistance of the conventionalists, and organized. Their earnestness and industry inspired thousands of others who had been waiting for a sign and who wondered why someone had not thought of it before.

The organizers realized that there was no need for another mere medical society. Their aim was an association which would embody their aspirations, a movement with dynamic prohibitions, and character enough to influence the recognition and acceptance of practical ideals.

"What then, these pioneers said, is our paramount business? How are we to begin? There must be no disposition to duplicate the work of others. There must be co-operation with all the profession in the lines of betterment. Our special leadership must be confined to neglected problems and paramount reforms.

First, back the cultivation of professional attributes. Emphasize these qualities rather than the commercial, specifically the buying of patients by commission giving, the unprofessional evil known as fee splitting which the College, with troublesome frankness, vigorously denounces.

Second, fix a standard for fellowship that will give proof of surgical proficiency, viz., proof of actual specialization in surgery for 8 years or more, an examination that will prove the quality of work through records of cases to be filed as evidence of actual operations, approval of moral and professional qualifications by a committee of peers in the applicant's own state backed by written references, evidence that he is a legalized practitioner, a graduate in medicine with the degree of M.D., a member of his local and the national associations of scientific medicine and require of each and every applicant a definite, signed declaration against the division of fees.

Third, frankly endeavor to increase pre-operative diagnostic efficiency which would lessen unnecessary operating and make necessary operating more safe and effective.

Fourth, standardize the hospitals and the laboratories—in a word, the environment or work shop in which surgery is performed.

Fifth conduct a practical research into the records and treatment of cancer—the clinic and hospital services of our nine thousand Fellows, and our two thousand accepted hospitals to be used as an amplified laboratory from which the consensus of experience and opinion may be gathered, and a yearly pronouncement formulated as to the best treatment for this dread disease.

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Then came beloved Ochsner, with his battle-axe pledge against commercialism and bluster. He developed into the watch dog of our growing treasury, acquired as no other man the ideals of the College, and after his labors was laid to rest, at his own bidding, in the presidential robe of the American College of Surgeons. Wise and faithful Charlie was promoted from the ranks, followed by the pride of Dixie, Matas, who told us all about it. Chipman with his wisdom and eloquence and then George Stewart, the wise Scot from Manhattan, who charmed us with his wit and instructed us with his maxims of common sense.

The consulting surgeons of the Armies of Great Britain sent Sir Berkeley Moynihan to us with a golden mace, an ancient club of authority which added a touch of tradition to our brand newness.

And so our field has grown and our jurisdiction has extended. At first Canada and the United States. How lucky that we fixed no boundary and that we did not exclude! Mexico, Central and South America are now among our workers. Australia and New Zealand applauded, asked for our co-operation, and complimented by imitating us.

The Presidents of the Royal Colleges of England and of Ireland, and of Scotland have honored us by becoming our Fellows and have commended our progressive organization. Our fellowship are valued not only in the British Isles, but in France, Spain, Italy, Norway, Sweden, Denmark, Holland, Belgium, Switzerland, India, China, Japan, and Africa.

Thus readeth the parable

## THEN WHY THE AMERICAN COLLEGE OF SURGEONS?

There was need for a comprehensive democratic association of surgeons and surgical specialists, an association or guild to which all practical surgeons could aspire for fellowship, where moral and spiritual ideals could be openly discussed and affirmed, where education and professional ability would outrank effrontery, commercial trickery, and social prestige.

Brave men risked the questioning and resistance of the conventionalists and organized their earnestness and industry, inspired thousands of others who had been waiting for a sign and who wondered why someone had not thought of it before.

The organizers realized that there was no need for another mere medical society. Their aim was an association which would embody their aspirations, a movement with dynamic proclivities and character enough to influence the recognition and acceptance of practical ideals.

"What then," these pioneers said, "is our paramount business? How are we to begin?" There must be no disposition to duplicate the work of others. There must be co-operation with all the profession in the lines of betterment. Our special leadership must be confined to neglected problems and paramount reforms.

First, back the cultivation of professional attributes. Emphasize these qualities rather than the commercial, specifically the buying of patients by commission giving, the unprofessional evil known as fee splitting, which the College with troublesome frankness vigorously denounces.

Second, fix a standard for fellowship that will give proof of surgical proficiency, viz., proof of actual specialization in surgery for 8 years or more, an examination that will prove the quality of work through records of cases to be filed as evidence of actual operations, approval of moral and professional qualifications by a committee of peers in the applicant's own state, backed by written references, evidence that he is a legalized practitioner, a graduate in medicine with the degree of M.D., a member of his local and the national associations of scientific medicine and require of each and every applicant a definite, signed declaration against the division of fees.

Third, frankly, endeavor to increase pre-operative diagnostic efficiency, which would lessen unnecessary operating and make necessary operating more safe and effective.

Fourth, standardize the hospitals and the laboratories—in a word, the environment or work shop in which surgery is performed.

SURGERY IN THE MEDICAL DEPARTMENT OF THE UNITED STATES ARMY<sup>1</sup>MERRITT W. IRELAND MAJOR GENERAL MC, U.S.A. D.S.M. F.A.C.S., WASHINGTON  
Surgeon General United States Army

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There were of course, more than 250 men practicing medicine. It has been estimated that there were 3,500, but most of them had no degrees nor more medical education than they had derived from a preceptorship. Such a man was Isaac Senter, the surgeon with Arnold's expedition to Quebec, yet he later attained great prominence in the profession and honorary membership in the medico-chirurgical societies of Edinburgh and of London and in the Massachusetts Medical Society. Such also was John Cochrane, who became the head of the Medical Department of the Army in 1781. Some surgeons and mates were mere boys, a few in their teens. Doubtless many men had no qualifications other than a desire to practice and a few rules of thumb.

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"At the commencement of the Revolutionary War we had one medical book by an American author, three reprints, and about twenty pamphlets. The book referred to is the *Plain, Precise, Practical Remarks on the Treatment of Wounds and Fractures* by Dr. John Jones, New York, 1775. It is simply a compilation from Ranby, Pott, and others, and contains but one original observation viz. a case of trephining followed by hernia cerebri.<sup>2</sup> This book, containing 114 pages 4 1/2 by 7 1/4 inches is usually found bound with *The Diseases Incident to Armies with the Method of Cure*, etc., a translation from Van Swieten of 164 pages of the same size.

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<sup>1</sup>Bill. 25 Century of American Medicine<sup>2</sup>Inaugural address. Clinical Congress of the American College of Surgeons. October 22-23, 1909

one of them. Without the loyalty and thoughtful industry of such a group there could not have been a College of Surgeons. Ballou, Farrow, Bowman, MacLachern, Craig, Salisbury, Carr, Leigh, Myers, Ulrich, Spencer, Perry, Walker, William son, Crowell and Grimm are names that deserve not only praise but permanent monuments.

Fellows of the College, I thank you for allowing me to stand here as your President. With your kind sufferance, when I retire from this position, I will return to my garden and your garden and work the best I can with the old implements and endeavor to practice what I preach.

#### PEACE JUBILEE

*Mr. Surgeon General.* May I remind this audience that 11 years ago 90 per cent of the Fellows of the American College of Surgeons enrolled for war service—40 per cent in the Medical Corps of the United States and Canadian Armies, 10 per cent in the Navy Medical Corps, and 40 per cent in the Volunteer Medical Service Corps of the United States for emergency service in either the Army, Navy, or Public Health Service.

May I remind this audience that the Fellows of this College organized the Committee of American Physicians for Medical Preparedness 18 months before the United States entered the World War, and the services of this Committee were recognized and accepted by President Wilson and Secretary Baker exactly one year before we entered the war.

May I remind this audience that it was the Fellows of this College who were at the head of the greater percentage of the 47 Base Hospitals that were organized in the United States by Colonel Jefferson R. Kean for service overseas. Several of these Base Hospitals reached England and France before any other American soldiers. Conspicuous among them were George W. Crile, Harvey Cushing, Frederic A. Besley, Angus McLean, Dean Lewis, George E. Brewer, A. J. Ochsner, L. L. McArthur, Charles H. Peck, John M. T. Finney, Fred T. Murphy, C. A. Evans, Arthur A. Law, J. F. Binnie, Stuart McGuire, J. B. Eagleson, Edward L. Keyes, C. L. Gibson,

R. H. Harte, Fred Kammerer, M. Clinton, Edmund D. Clark, W. A. Elting, A. P. C. Abbott, J. J. A. Van Kaathoven, Burt R. Shurly, Edna H. Fiske, William F. Wesselhoeft, R. T. Miller, David Barrow, William H. Goodwin, E. C. Davis, William Gillespie, Charles Levison, William Francis Honan, A. C. Stokes, and Samuel Lloyd.

I hope that it is not amiss to state in the presence of our incoming president—a warrior by profession but a peace advocate by nature—in this the Jubilee Year of peace, with Presidents, Premiers, Secretaries of State, and Ambassadors straining at their leashes in their efforts to make war a misdemeanor and peace permanent that these efforts are welcomed by this organization that took a leading part in the prosecution of the World War.

May I read an excerpt from a letter written by our great United States War Secretary, Newton D. Baker, who, as you will see, appreciated our work in aiding his great task.

Perhaps because I was the son of a doctor and came near studying medicine as it was possible to do and still miss it, I had especial interest in the work of the medical corps during the World War. Nobody could have been in close contact with Gorgas without realizing his gentle greatness and as he gathered about him the most devoted and eminent members of the profession I felt that I was admitted to the inner sanctum and permitted to see the optimism and inspiration which characterizes the great medical profession in these days of magnificent progress.

I would like to have had a chance to say some of the things that are in my mind and heart about doctors generally but as it is I must resist the temptation and merely express to you the deep appreciation I feel for the honor which your invitation does me.

*The gavel.* This our gavel was devised and used by Lord Lister and was presented to the American College of Surgeons by Sir Rickman Godlee, then president of the Royal College of Surgeons of England, in memory of his visit to Chicago November, 1913.

*The Great Mace.* The Great Mace was presented to the American College of Surgeons by Sir Berkeley Moynihan (now Lord Moynihan) in 1920. It is the gift of the Consulting Surgeons of the British Armies to their confreres in Canada and the United States.

# SURGERY IN THE MEDICAL DEPARTMENT OF THE UNITED STATES ARMY<sup>1</sup>

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necessary that each be a general practitioner. Thus Benjamin Rush was successively surgeon general and physician general in the Central Department. A century later, in 1876, Samuel Gross wrote 'It is safe to affirm that there is not a medical man on this continent who devotes himself exclusively to the practice of surgery. On the other hand, there are few physicians even in our larger cities, who do not treat the more common surgical diseases, such as fractures, dislocations, and wounds, or who do not even occasionally perform the more common surgical operations.'

This rather long introduction is by way of preparation and explanation for the fact that the surgery of the Revolutionary War was not great, although it must have been greater than the record left of it. There were of course, other reasons why it was resorted to only in cases of dire necessity, chief of them being the absence of anesthesia, the danger of injury to vessels and nerves, and the practical certainty of infection the causes and nature of which were wholly unknown. In fact John Jones attributed inflammation in all cases to pain and irritation and taught that measures of prevention or treatment had little influence 'without premising opium.'

The principal operations were amputations, cutting for stone, cutting fistulous tracts and opening abscesses. John Jones cut for stone, but that was not a part of military surgery. The major part of surgical work was dressing suppurating wounds; the surgeon's best omen was pus. The care of backs suppurating as the result of flogging was an important part of the military surgeon's work. Even simple fractures and dislocations were crudely treated and bad results must have been frequent.

There were types of wounds not seen today for example the case of Captain Greg related by Thacher. Greg was shot through the arm and chest, tomahawked in the back and head and scalped yet he was nursed through to health. Scalping was performed by the Indian as follows: "With a knife they made a circular cut from the forehead quite round, just above the ears then taking hold of the skin with their teeth they tear off the whole hairy scalp in an instant with wonderful dexterity."

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Mann had read Larrey and he discusses his indications for amputations on the battlefield, agreeing with him in most instances but not in all, contending that many joint injuries and fractures in the upper parts of limbs would do well under treatment. His opinion was based upon experience, his own and that of others. He was happy in escaping the most serious wound infections and he states that he saw no tetanus, hospital gangrene or other infection. This he attributed to his care in whitewashing walls, sanding floors and maintaining strict cleanliness in his hospitals. He said 'When patients die in foul hospitals, the surgeons are as culpable for their deaths as if they had been improperly treated by medicine or wholly neglected.' He was a believer in the antiphlogistic treatment of wounds by bleeding and purging and said that the more blood expended the better in wounds of the viscera, provided life is not extinguished when hemorrhage is stopped. A soldier at Greenbush was wounded with a bayonet, which entered the left of the spine and passed through the trunk below the diaphragm. This man was attacked with puking and suffered extreme pain. He was bled immediately; the operation was repeated as pain indicated until he lost 2 quarts in 36 hours. Within 3 days the puking ceased and the man became composed. At the expiration of 3 weeks the wound healed without suppuration.

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A most distressing scene ensues at the Hospital—nothing but the Groans of the wounded and the agonies of the Dying are to be heard. The Surgeons wading in blood cutting off arms, legs and trepanning heads to rescue their fellow

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geon's mate in the War of 1812 He relates little of importance that was not told by Mann Ointments and cerates, particularly basilicon, were used in dressing nearly all wounds, and poultices he preferred to cold water dressings prior to the onset of suppuration

The losses in the fighting in northern New York in 1814 were extraordinarily heavy and the burden upon the hospitals great

Under these circumstances many soldiers were treated in the outskirts of the hospital by their wives or females having an attachment to them With such assiduous recoveries took place which would scarcely have followed in ordinary hospital practice

Bullet wounds which did no injury to bone or to the great cavities generally did well

Out of many cases of fractured os humeri or os femoris which I saw a majority of the patients died or were compelled to submit finally to amputation

During the heat of the summer our large amputations were very unsuccessful so much so as almost to discourage us from performing them many of the recent stumps mortified in others that did not the patient gradually sank into the arms of death

Wounds attended with much discharge were frequently infested with maggots the ova of which were deposited by flies (*musca canaria*) in the bedclothes and dressings This accident will probably be attributed to negligence but the most diligent of nurses could not prevent it

At one time the author had the sole attendance and dressing on one hundred and seventy three sick and wounded My fingers became so sore from incessant dabbling in water and in pus that I could see nothing without pain and was constantly liable to let articles fall from the sudden twinges of agony in touching them

Horner discussed at length the moot question of early or late amputation for gunshot fracture and said

Our own general conclusion from what we have seen and learned would be that amputations in the length of the bones of the upper extremity anywhere below the shoulder joint may be performed indiscriminately either at once or subsequently Perforations by balls through the elbow or wrist in their ulterior consequences involve great hazard to the life of the patient but some patients recover It is perhaps therefore better to delay the amputation as there is no immediate danger for the most part Compound fracture of the thigh is imminently dangerous either with or without regular amputation An intermediate plan has therefore been suggested which for similar reasons may be applicable to the leg also to-wit the excision of the limb through the ray of attachment and the simple squaring off of the ragged end of the bone

There were some well marked advances in surgery before the Mexican War notably Mc Dowell's ovariectomies and operations for the cure of hernia Plastic and ophthalmic surgery had also progressed but none of these advances had yet found a place in military surgery, so far as I know The great and outstanding advance of the time was the introduction of anæsthesia,

<sup>1</sup> B. Goss. A History of Medicine 1876

<sup>1</sup> Med. Rep. 11: 407

<sup>2</sup> Med. Rep. 106

<sup>3</sup> Edinburgh M. & S. J. 1816 April 1: 126-130

<sup>4</sup> Medical Exam. & Record of Medical Science New Series 10: 4

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During the heat of the summer our large amputations were very unsuccessful so much so as almost to discourage us from performing them many of the recent stumps mortified in others that did not the patient gradually sank into the arms of death

Wounds attended with much discharge were frequently infested with maggots the ova of which were deposited by flies (*Musca carnaria*) in the bedclothes and dressings This accident will probably be attributed to negligence, but the most diligent of nurses could not prevent it

At one time the author had the sole attendance and dressing on one hundred and seventy three sick and wounded My fingers became so sore from incessant dabbling in water and in pus that I could seize nothing without pain and was constantly liable to let articles fall, from the sudden twinges of agony in touching them

Horner discussed at length the moot question of early or late amputation for gunshot fracture and said

Our own general conclusion from what we have seen and learned would be that amputations in the length of the bones of the upper extremity anywhere below the shoulder joint may be performed indiscriminately either at once or subsequently Perforations by balls through the elbow or wrist in their ulterior consequences involve great hazard to the life of the patient but some patients recover It is perhaps therefore better to delay the amputation as there is no immediate danger for the most part Compound fracture of the thigh is imminently dangerous either with or without regular amputation An intermediate plan has therefore been suggested which for similar reasons may be applicable to the leg also to wit the excision of the limb through the ray of attachment and the simple squaring off of the ragged end of the bone

There were some well marked advances in surgery before the Mexican War, notably Mc Dowell's ovariectomies and operations for the cure of hernia Plastic and ophthalmic surgery had also progressed<sup>5</sup> but none of these advances had yet found a place in military surgery, so far as I know The great and outstanding advance of the time was the introduction of anaesthesia,

<sup>1</sup> D Gross. A Century of Medicine 1376

<sup>2</sup> Med Repos 1 407

<sup>3</sup> Med Repos 106

<sup>4</sup> Edin Med M & S J 120 Apr 1 1836 159

<sup>5</sup> Medice J L Am J of Med & Record of Medical Science N S Series VII &

which found prompt application in the army. The official records of the surgery of this war are as defective as for the War of 1812 or the Revolution, but two surgeons published informing articles with good description of their work. The fuller of these writings were those of Surgeon John B. Porter, U. S. A. Porter<sup>1</sup> describes about 30 gunshot wounds, discusses the principles of treatment laid down by Larrey and by Guthrie and expresses his own opinion.

He agrees that (1) 'wounds of the head, unless slight, may be considered dangerous. He details five cases, ranging from slight to severe, in all of which the treatment was purely expectant.

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4 Penetrating wounds of the chest are dangerous," but he reports two cases resulting in recovery. One of these was apparently not penetrating and in the other the missile was a buckshot.

5 'Gunshot wounds of the abdomen are always fatal.' Thus he emphasizes by two case reports but he also admits that recovery has occurred in rare cases.

6 Wounds of the pelvis and parts adjacent are exceedingly dangerous. He reports two corroborative cases, one suggesting carelessness in examination. 'The shot struck the upper part of the thigh and inguinal region, external to the large artery. There was no mark of exit. He was brought into hospital late at night and on examination the wound appeared exactly like having been made by the brush of a ball passing by and just touching the integuments and cellular membrane, and what added to this impression was that there were no constitutional symptoms and the patient actually walked, voluntarily, several steps to the bed provided for him. Two weeks later he died. Autopsy. The head of the femur was shattered into several pieces and the acetabulum was shattered in all directions and driven in the grapeshot was found imbedded in the glutei muscles.

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hand and forearm, and gunshot wounds of the upper third of the femur are among the most terrible that can be inflicted." He details thirteen cases in support of this thesis, one particularly interesting because used to point a moral in regard to the use of ether anesthesia. 'But the operation was not successful nor was this surprising.' On making the incision the blood was dark and venous as it was from the arteries also. The muscles were darker than usual. Adhesion did not occur between the flaps and after granulations appeared up it was found that the flaps were too short to cover the bone. The explanation follows. In this case the blood was poisoned and the muscular contractility destroyed, hence the soft parts were found insufficient to cover the bone after the patient had recovered from the deleterious effects of ether. I have often thought that the effect of the inhalation of ether in those cases in which it was employed was as injurious as any other malignant influence whatever. At the close of the war I had determined never to use it again. Let us hope that he changed his mind.

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Suppuration and sloughing always occurred. Gunshot fractures not requiring amputation were treated like flesh wounds after loose fragments and foreign bodies were removed.

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The hyonet entered between the seventh and the eighth ribs wounding the lung from which there was tremendous hemorrhage. Surgeon Haskell saw the man and bled him copiously. He was again bled as soon as reaction and hemorrhage came on. These decisive bleedings doubtless saved the man's life.

W. B. Herrick,<sup>2</sup> Professor of Surgery at Rush wrote of his experience. It was the practice to remove with care any foreign material in the

wounds and then to dress them with lint and bandages. For hæmorrhage he used compresses and tight bandaging. Ligation was rarely resorted to. If amputation was deemed necessary it was done at once. Herrick favored heavy, moulded pasteboard splints for comminuted gunshot fractures.

Between the Mexican and the Civil wars surgery made notable advances. Three surgical specialties, gynecology, rhinolaryngology, and operative ophthalmology, all became useful realities. More important from a military standpoint was the enlargement of general surgery, the increase in operative work, consequent upon the introduction of anesthesia.

Of tremendous importance also was the fact that the Crimean War had been fought, with losses due to preventable diseases which shocked the world, had brought Florence Nightingale to her great work of mercy and reform, had led to the making over of the Royal Army Medical Corps, but was unable to dent the self-complacent stupidity of the French *Intendance*. Thus it happened that the world was treated to a great object lesson, losses alike terribly great in the English and the French armies one year, in the next thirteen times as high in the French as in the English army.<sup>1</sup> With this lesson in view efficiency in our Medical Department was a necessity, but not a fact. Hence the importance of an outside agency, the Sanitary Commission, to bring about a reform. That is a great story which I should like to tell, but I have not the time. However the reform resulted in good evacuation of the wounded, good hospitalization and with its agony almost removed by anesthetics, operative surgery practiced on a scale never before seen. There were hundreds of skillful operators, more hundreds less skillful. Amputations, excisions, ligations were on a scale unprecedented. There were even some attempts at surgery of the abdomen, chest and cranium. Unfortunately, no more was known of asepsis or antiseptics than in our preceding wars. Lister himself had not taken the matter up so infections were general. Pus, erysipelas, abscesses, septicæmia, pyæmia, hospital gangrene kept mortality high and surgery low. Happily these evil complications were not aided by such bleeding, salivation, purging, and blistering, as had been used in our earlier wars. Still surgical mortality was high.

You all know something of the *Medical and Surgical History of the War of the Rebellion*, al-

though not so familiar with it as surgeons of one or two earlier generations. The three enormous surgical volumes discuss in great and informing detail the classes into which the 245,700 wounds were divided, their treatment and results. Here we learn that there were 900 operations on the skull, 138 operations for gunshot wounds of the neck, including 29 ligations and 14 laryngotomies or laryngotracheotomies, five of them successful. Plastic surgery was practiced occasionally for face mutilations. There were 62 operations for wounds of the vertebra, including removal of bone fragments and of bullets. Ten surviving cases are reported. For perforating wounds of the chest "hermetical sealing" came into use with splendid results when infection was escaped. This was, of course, a step in the direction of Lister's later work. It was done early, by means of lint and collodion. There were 494 operations for chest injuries, with 198 deaths. There were 8,715 penetrating gunshot wounds of the chest, with 5,260 deaths, so the operative cases gave much the better results. Enterorrhaphy was practiced, 62 cases of wounds of the liver recovered and 444 of 3,717 abdominal wounds. The compilers of the history advised laparotomy for abdominal wounds thereafter. They also stated that bleeding was not used for such wounds in the Civil War. Many medical men still used mercury for its antiphlogistic effects, but opium was the mainstay.

Amputations were still extensively practiced for gunshot fractures, and excision of bones or parts of bones were also often resorted to in lieu of amputation, but as experience accumulated it became evident that conservative treatment yielded on the whole better results, more survivals, than either amputations or excisions. The mortality for all excisions was 27.6 per cent for all (1,980) amputations, from finger to hip joint, 26.3 per cent. All arteries up to and including the common iliac and the innominate were ligated. Surgery was manifestly bolder, more skilled and more successful than in earlier wars. The tales of hospital gangrene, erysipelas and other serious infections lead us to think they were common. In fact they were not. There were but 1,097 cases of traumatic erysipelas or 0.4 per cent of wounds, but 2,642 cases of gangrene, including hospital gangrene but 505 of tetanus. Pus, if 'laudable,' was not regarded as pathological and mere suppuration was not included among 'infections.'

The Civil War taught surgery to thousands, it made operations familiar, it prepared the way for the great expansion which followed the practice

<sup>1</sup> *See Histoire des Trésors du Corps du Santé militaire. Bull. de la Société Française d'Histoire, 1913, 221, 92-103.*

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<sup>1</sup>Am. J. M. Sc. for the years 1852, 1853, and 1855.

<sup>2</sup>Illinois M. F. Diana M. & S. J. 847 48 iv 225 414

PRESENTATION OF CANDIDATES FOR FELLOWSHIP<sup>1</sup>

FRANKLIN H. MARTIN, M.D. CHICAGO  
Director General American College of Surgeons

*Mr. President* Each year as we receive a new class of candidates into Fellowship I am impressed by the prestige of an institution that can influence such a goodly number of busy practitioners of surgery to seek its portals.

To the casual observer these men appear as one more group that is being enrolled into our ranks. Complacently, this observer shrugs his shoulders and reflects 'How easy!'

May I remind this observer, and this audience that has honored us with its presence, that the majority of this goodly number of successful candidates who have presented themselves have been reminded by their successful entrance into the American College of Surgeons of a well worn saying. It compares the chances of entry into Heaven of a successful Captain of Industry with the chances of a certain deformed animal to pass through the eye of a needle.

As an illustration

There were 4,197 applications for Fellowship on file January 1, 1929. 664 of them had already received the approval of State or Provincial Committees on Credentials. 1,424 were presented to State and Provincial Committees on Credentials during this year, 1929 of which only 678 or 47.5

per cent were approved and recommended for examination. Of the total recommended for Fellowship before and since January 1, 1929 (1,342), our careful sifting process has admitted to Fellowship only 669 or 49 per cent constituting the candidates who are here present.

Surely if we pay tribute where tribute is due we must pay full portion to the magnificent group which is before us this evening. Veritably they are the survival of the fittest.

They are to be congratulated, and the College is to be congratulated, but above all, we must congratulate the people who shall in the future seek their services.

## CLASS OF 1929

United States	642
Canada	11
Hawaii	7
Porto Rico	1
Australia	1
France	1
India	1
Japan	1
Persia	1
Siam	1
South America	2
Total	669

<sup>1</sup>C Invocation American College of Surgeons October 8 1929



of antiseptics, with its virtual removal of danger. But in the decades immediately following the war the dangers were still great and surgery was mainly work of necessity, although, as Gross said, every doctor was doing it.

Before 1880 a small number of American surgeons had taken up Lister's practice. Among the early advocates of it was Captain A. C. Girard, who in 1877 wrote enthusiastically in regard to it. His article was published in the *Medical Record*<sup>1</sup> and to the service in a circular of the Surgeon General's Office. In 1878 a spray apparatus was issued to the service. In 1892 the antiseptic first aid packet of German origin was adopted in our service and antiseptic surgery was being relatively widely used.

The Spanish American War was, on land mainly a war of small arms, of small pointed bullets. The wounds were for the most part mild, the first aid dressings were effective, and most wounds healed without infection. Surgically the war was a success. That and the subsequent Philippine campaigns again popularized surgery. So safe had it become, so self-reliant its disciples, that we actually have the official record of a thoroughly successful amputation above the elbow performed by two hospital corps men in the Philippines, neither of them a medical man (S. G. R., 1900, p. 160).

Anæsthesia and antiseptics enabled many men to do operations for the selection and application of which neither their education nor their judgment qualified them. As a result surgery suffered some discredit for a while.

In the World War the surgery was done by you gentlemen from civil life. So tremendous was the expansion of the Medical Department that it was necessary to place practically its entire regular personnel into administrative work, and

few were the regular officers who could do professional work.

Concerning the surgery of the World War I shall not attempt to tell you, because you know it as well as I, or better. I may properly express my gratitude that we had you to do it, that it was the greatest surgery of any war in history, that its results were better than ever before, that the Government's care for the soldier extends to the present time in all cases needing such care.

Despite the fact that two thirds of the wounds were made by explosive missiles, 90 per cent were saved. A few comparisons with Civil War results are interesting.

#### PERCENTAGE OF DEATHS

	Civil War	World War
Wounds of cranium	60	40.8
Wounds of chest	62	39
Wounds of abdomen	85	43.4
Wounds of ankle joint	53	10.6
Wounds of knee	54	12.5
Wounds of hip	85	2.2

The advances in the treatment of deformities in orthopedic, plastic and head surgery can scarcely be estimated, except to say that they were very great.

What regular officers, Colonel Keller for example, have done for the chronic bone cases, chronic empyemas, and such other sad sequelæ as have been under treatment since you left the service, I believe you know. I believe that with me, you are proud of it, that you feel that it has been most creditable to the profession.

With the most cordial hope that the mutual pride of the surgical profession and of the Medical Department in one another shall never change except in the way of increase, that in time of need we may ever be mutually helpful, I convey to you the gratitude of my department for what you are to us.

<sup>1</sup>*Med. Rec.* 1877, xii, 721, 726.

that was ordinarily required for the diploma. We learn from Thacher's *Medical Biography* that Josiah Bartlett was surgeon's mate in the Revolution at the age of 16, and John Thomas of Massachusetts was surgeon's mate at 17 and regimental surgeon at 18 years. Both of these men later attained prominence in their profession.

*Surgery*, without asepsis, antiseptics, or anesthesia was necessarily crude and unsatisfactory. Amputations were frequent and pus was the surgeon's best omen.

*Hygiene* had scarcely advanced beyond the teachings of Moses in any directions. In some respects it had fallen lamentably behind.

In such circumstances as the preceding remarks indicate the medical service (not yet a corps) of the United States Army came into being. The average number of medical officers in service from the Revolution to 1830 probably did not exceed 30 to 40. They were usually isolated in small places, yet from one of these, a lone doctor in a frontier post separated by a hundred miles of distance and a week of travel from his nearest fellow physician, came America's first large contribution to scientific medicine.

William Beaumont, post surgeon at the fur trading, frontier post of Fort Mackinac, was the contributor and his contribution was the brightest light thrown upon the physiology of digestion up to that time. An accident of rare and happy outcome gave him the opportunity to observe in the living body the appearance, action, and digestion by the healthy human stomach. Although without a medical degree, Beaumont was blessed with an inquisitive spirit, a clear mind, the powers of concentration and perseverance. Alexis St. Martin's accident afforded him the means for making observations of great importance, and his clear understanding and lucid style enabled him to relate most interestingly what he had observed. Before him the subject of digestion was almost pure speculation. Even Spallanzani, whose observations and experiments were the most important prior to Beaumont's failed to recognize that the gastric juice was normally acid. Prout isolated free hydrochloric acid from it in 1824 but no one knew the story as Beaumont told it.

Beaumont drew 51 inferences from his observations all of them new to most medical men and it may be said that more than 90 per cent of them are valid today and are among the fundamentals of the physiology of digestion. His most striking mistake was the belief that every species of aliment produces the same kind of nutrient principles, which he called for convenience of illus-

tration, a *gastrite of aliment*, as one might speak of a *nitrite of sodium*.

Next in scientific importance, and of about the same time, was the Medical Department's system of weather reports, instituted by Surgeon General Lovell and sent in from all posts. These were the beginning of the weather bureau service. In 1844 the first weather maps were made in the Surgeon General's Office. It was not until 1870 that the weather reporting was transferred to the Signal Corps, which in turn transferred it to the Weather Bureau in 1890.

During the Mexican war our contribution was valor and hard work, little else. In the 1850's the Pacific railway surveys were made and many medical officers contributed interesting and useful observations on the fauna, flora, ethnology, and archeology of the regions traversed. Most interesting were Dr. George Suckley's reports as surgeon of the party exploring the Northern route.

Another type of contribution to civilization, that of the hardy, fearless Indian fighter, is revealed in Surgeon J. B. D. Irwin's of Apache warfare experiences in 1858. Irwin and his like were contributors of the type of Daniel Boone and Kit Carson. Bravery, resourcefulness, initiative, and responsibility were their characteristics.

The greatest contribution from the Medical Department in the Civil War lay in the organization systematization, and co-ordination of medical work, especially in the removal, transportation and subsequent care given the wounded. This excelled anything of the sort previously done. It served as the model from which were built the systems of evacuation and hospitalization used in the World War. For this great contribution we are indebted principally to two men, Surgeon General William H. Hammond and Surgeon Jonathan Letterman, the two great medical officers of that great time. The story of their work is romantic that of Hammond melodramatic. To his initiative and his orders we are indebted for the material for the Army Medical Museum and the *Medical and Surgical History of the War of the Rebellion*. I suspect that his "Calomel Order," Circular No. 6, 1863, was truly a great step in freeing us from blind subjection to the systems of the past, particularly the teachings of Benjamin Rush. Recall that James Tilton said that besides syphilis, itch, etc., without fever, it is regarded as specific in smallpox, measles, scarlatina, influenza, yellow fever, etc., and is found to be not less successful in the early stages of jail fever. Hence it is that in yellow fever remitting or any other fever, if we can only touch the patient's mouth with mercury, we regard him as safe."

THE MEDICAL DEPARTMENT OF THE UNITED STATES ARMY<sup>1</sup>

MERRITTE W. IRELAND, MAJOR GENERAL U S A, DSM, FACS WASHINGTON  
*Surgeon General United States Army*

**F**EELING that you bestowed upon me the high honor of your Presidency for the reason that I am the head and so the representative of another organization with which most of you have had close affiliation, the Medical Department of the Army, I cannot do better than to talk of this and of its contribution to civilization.

The need for a military medical organization became apparent at Bunker Hill. Massachusetts provided it temporarily, but one of Washington's early recommendations to Congress was for the establishment of 'an hospital,' meaning thereby a medical service outside of the regiments. This Congress did, and during the period of the Revolution it frequently legislated in regard to the hospital. Some of the legislation was very liberal and gave to the medical authorities great apparent freedom to do whatever was necessary. The country was poor, inexperienced, poorly organized and the doctors had no military rank. It would be easy to argue that these circumstances prevented the success which they would otherwise have had, but I do not believe that it would be honest. They were very much more hampered by the ignorance of their day than by laws. To outline briefly the military medicine of the day let us consider some of its branches.

*Anatomy* Gross descriptive anatomy was pretty well known to a few. Most medical men of America had not dissected a body.

*Physiology* This subject was still pretty primitive. The functions of the nervous system were known very slightly. Harvey had, of course demonstrated that the blood circulates and Malpighi had shown the capillaries but most teachers even so great ones as Blumenbach, Haller and Cullen did not speak of them but said that the arteries emptied into veins and the veins rose from arteries. Digestion was quite a mystery. The best work done upon it up to the time of Beaumont, 50 years later was that of Spallanzani, whose ingenious experiments taught much about gastric juice, but not that it was acid.

*Respiration* could not be understood as oxygen and carbon dioxide were just becoming known and Lavoisier himself had not yet wholly clarified his own views. Obviously, then all cellular metabolism was unknown.

*Electro Physiology* was not yet in terms of speech or thought. There was much speculation

as to humors of the body, but they were hypothetical humors, totally unrelated to the antibodies and hormones which might be so classed today.

*Pathology* had not passed, in America it had scarcely grasped the organ pathology of John Hunter. The cell its physiology and disturbances were unknown. Medicine was scholastic practice governed by "systems" founded upon hypotheses, some of them fantastic. The cause of no disease was known and the room for speculation was infinite. The means of investigation of disease were the unaided senses and these gave information mainly as to symptoms. The most esteemed art used in diagnosis was the palpation of the pulse. There were no instrumental aids to diagnosis, no clinical thermometer, no blood pressure apparatus, no stethoscope or other 'scope,' no chemical or microscopic examination of blood or excreta. The distinction between diseases and symptoms was by no means clear, and fever, jaundice, dropsy, cough, diarrhoea and vomiting were treated as diseases in themselves. Many men, notably Cullen, tried to differentiate diseases into many kinds and to classify them into genera and species. Benjamin Rush in his *American System* taught that these efforts were unnecessary, vain, and even harmful, and that what was necessary was to know the 'nature' of the diseases, whether they required depletion or stimulation. Such were the stimulating qualities of the American climate that nearly all diseases in this country required depletion. This meant bleeding, purging, vomiting, low diet, sweating and salivation. Alcohol, food, 'bark,' opium and blisters were stimulating. Salivation in addition to its depleting virtue, was regarded as specific treatment for all fevers. James Tilton expressed the general belief and practice when he wrote "This Sampsonian remedy has the power of subduing all manner of contagion or infection that we are as yet acquainted with." Tilton was head of the Medical Department in the War of 1812.

*Materia Medica* included no alkaloids or isolated active principles merely crude drugs most of them nauseous and many valueless.

None of the present day specialties was practiced as such. One man could acquire all medical knowledge and one year of medical school was all

<sup>1</sup> Presidential Address delivered at the Convocation of the American College of Surgeons, Chicago, October 18, 1929.

and dysentery, but it is greatly heartening also to observe the notable saving from those great respiratory killers, phthisis and pneumonia.

Pneumonia we are apt to think of as being as deadly as ever, appendicitis causes the lary to wonder why our ancestors did not have it, and prohibition has given deaths from alcoholism such news value that we see more reports of them in the newspapers than we saw years ago. The figures here quoted show that deaths from all of these are now rare as compared with 1841.

There is much of which I should like to tell you as showing the progress of medicine and of the Medical Department, but I may not take the time. But allow me to remind you that the official history of the *Medical Department in the World War*, a work comparable to the *Medical and Surgical History of the War of the Rebellion*, is now complete, the last volume in the hands of the printer, and that I hope and believe it will prove as great a mine of useful information as did the last named work.

I can not close this much condensed account of the work of the Army medical service without expressing my great satisfaction that the Department no longer, as through the greater part of its history, consists solely of medical officers. Not only has it its own enlisted personnel, but it includes the Dental, Veterinary, Medical Administrative and Nurse Corps, and by virtue of that fact its usefulness in the future promises to be greater than in the past.

Nor can I withhold my appreciation of the happy relations it now has with the great medical services of the Navy, the Public Health Service, and the splendid civil profession upon which it has called and will call, and never call in vain, for help in time of trouble. Most of you were with us in person in the late war, all of you in spirit. The honor you have done me is a gesture of good will which I and my Department appreciate most gratefully—a guarantee of co-operation and perhaps guidance in our next great task, the control of the respiratory diseases.

practical elimination of typhoid from the army, where it had been a scourge throughout all of our history. So striking were the results that the procedures were taken up by other armies and in civil life, and typhoid, once so common, is now a rare disease in this country and many others. Here was a great gift to civilization, a great accomplishment of medicine. The same measures other than bacterial prophylaxis, which so reduced typhoid, also reduced dysentery, likewise a long time scourge to our army, formerly such to our country and still such in our tropical possessions. It is now relatively rare. Among the measures of general sanitation important in reducing these diseases, not only in the army, but also in our cities and the cities of the world, it is probable that no single one is more important than the chlorination of water. This is applied in the field by the use of hypochlorite of lime, but that substance was difficult of application and uncertain in results when applied to the water supplies of great cities. To an army medical officer, the modest Carl R. Darnall, my office assistant, the world is indebted for the process of purification of water by the use of liquid chlorine and for the apparatus by means of which the treatment is effected. When I say that we are indebted for these things to Colonel Darnall I am not expressing a mere opinion. The patent offices of this and other countries recognized his priority by granting him basic patents and the United States Courts have upheld the validity and rightfulness of those patents. Here is a contribution to civilization which reaches into and benefits every urban home in America and in many other parts of the world.

The specific treatment of amoebic dysentery with ipecac was brought into prominence in our country by a medical officer, Colonel A. A. Woodhull, and the use of emetine followed the work of another, Colonel E. B. Vedder. Another officer whose work on dysentery and malaria has made him an authority on both is Colonel C. F. Craig.

A disease which was of primary importance in the Far East, several times as disabling to the Japanese army in the Russo-Japanese war as all communicable diseases combined, and very common among Philippine Scouts and in public institutions, was beriberi. It had been investigated by British, French, Dutch, and Japanese workers, but again it was the American Army Medical Department which gave a large scale demonstration in practical control. The Tropical Disease Board in Manila recommended changes in the Scout ration which practically eliminated the disease in a few months. The same changes applied in the prisons, leper asylums, and Constabulary had the same

effects, with great saving of life and prevention of invalidism. To the Far East the control of beriberi is as important as the control of typhoid in the western world.

Another disease which has afflicted its many thousands in our army and our country is dengue. Benjamin Rush certainly talked of it under the title of bilious remittent fever, and under that title it was long confused with malaria and yellow fever. Tropical Disease Boards in Manila shed such light upon it that it is now as well understood as yellow fever, to which it has many resemblances.

An interesting view of the results of preventive medical work of the army at the present time and almost a century ago is obtained by comparing certain figures relating to the year 1841 with those relating to 1927. In 1841 the mean strength of the army was 9,748, the admissions to sick report 38,559 or 3,960 per 1,000, and the deaths 381 or 30.8 per 1,000.

In 1927 the mean strength was 13,901, the admissions to sick report 87,000 or 6,346 per 1,000, the deaths 531 or 4 per 1,000.

The admission rate had fallen to one sixth, the death rate to one tenth of the earlier figure.

In 1841 almost half of the army, a mean strength of 4,738, was in Florida. The admissions to sick report there amounted to 21,071 or 4,430 per 1,000, the deaths to 254 or 53.6 per 1,000.

In 1927 the troops in Panama numbered on the average 7,179. The admissions to sick report were 6,185, or 861.54 per 1,000, the deaths 29 or 4.04 per 1,000. The sick admission rate in Panama in 1927 was but one fifth that in Florida a century earlier, the deaths less than one thirteenth.

Even more striking are the death rates from certain groups of diseases as follows:

Diseases	Deaths in 1841	per 1000 in 1927
Fever—		
Typhoid	0.2	0.3
Typhus		
Malaria		
Yellow		
Dysentery	14	0.4
Diarrhea		
Pulmonary Tuberculosis	3	0.7
Eithitis		
Hemoptysis	1.2	3.1
Pneumonia		
Pentomitis	2	1.3
Appendicitis		
Typhitis	1.2	0.3
Alcoholism		
Intemperance		
Delirium tremens		

It is obvious at a glance that our great savings of life have been in the groups of fevers, diarrheas



*James J. Jones*

THE MEDICAL REVOLUTION<sup>1</sup>

## A STUDY IN THE HUMANIZATION OF SCIENCE

GLENN FRANK MA LITT D MADISON WISCONSIN

President The University of Wisconsin

I SHALL not speak to you in terms of your limited specialism as surgeons, but in terms of your larger significance as members of the high apostolate of healing. It would be a sterile presumption on my part, as a layman, to undertake to discuss any of the technical procedures of your craft, but, as the administrative head of a university of which a medical school and allied hospital units are integral parts, I sustain at least a Platonic relation to some of the larger issues of policy that confront your fellowship. And out of the experience of that relationship, I want, if I can, to capture a living sense of the particular phase of evolution through which it seems to me, the practice of medicine in its varied modes and manners is now passing.

It was a crisp November afternoon. The tonic wine of autumn was in the air, making for clarity of mind and health of outlook. The presidents of half a hundred American universities had come together for mutual counsel. The fundamentalist-modernist controversy was at fever heat. Here and there and yonder, legislators seemed bent upon taking learning in hand. There were disturbing signs of a renaissance of superstition. These presidents were concerned over the possibility of a popular movement that might compel the voice of science to echo the vote of the majority.

'Do you believe in hell?' asked one president of another.

'Why shouldn't I?' replied the other president, 'I am just launching a medical school at my university.'

The widespread reputation of medical schools as seed beds of dire difficulties for university administrators is not due, I am sure, to there being more *prima donna* temperaments among doctors than among engineers and lawyers but grows naturally out of the fact that the world of medicine is today in the throes of a far reaching readjustment, in which even the wisest are sometimes at wit's end.

The historian of medicine will look back upon the period following 1875 as the time of the Medical Revolution, as the historian of industry looks back upon the period following 1779 as the time of the Industrial Revolution. In both in-

stances new forces came into the field destined to alter profoundly the prevailing policies and procedures.

If I may generalize very broadly, this Medical Revolution was brought about by the entry of the science of medicine into a field before occupied in the main by the art of medicine. Medicine is admittedly both an art and a science. And the Medical Revolution will not bear its full fruit unless, as the ultimate result of its readjustments, the best in the art of medicine and the best in the science of medicine meet and merge both in the practice of the physician and the program of the profession.

But revolutions are treacherous adventures unless they are engineered by men who possess both the hindsight of the historian and the foresight of the statesman. In revolutions we always run the risk of throwing to the winds the eternal as well as the obsolete elements of the old order. And I am not at all sure but that in the necessary promotion of the science of medicine we are today in danger of losing some of the precious values developed in the practice of the art of medicine over the generations.

The 'old doc' of the sick room as well as the "super doc" of the laboratory must be reckoned with in any sound development of medicine. Old doc—I use the term in affectionate admiration—will always keep a tight hold on the heart strings of humanity. I wonder whether you know Opie Read's whimsical picture of old doc as he knew him in the South of an earlier day. Let me share with you the pleasure I had in reading it.

His house was old with cedar trees about it a big yard, and in the corner a small office. In this professional but there was only one window the glass of which was dim with dust blown from the road. In the gentle breeze the lilacs and the roses swapped their perfume while the guinea hen arose from her cool nest dug beneath the dabbas to chase a katydid along the fence and then with raucous cry to shatter the silence. The furnishings of old office were less than modest. In one corner a swayed bed threatened to fall in another a washstand stood epileptic on three legs. Nailed against the wall was a protruding cabinet giving off sick room memories. To go into his office and to come forth with no sign of heaving, was a confession of the loss of smell. Sheep-shearers fill the nostrils with woolly dullness, but sheep-shearers could scent old doc as he drove along the road.

<sup>1</sup> Fellowship address delivered before the Convocation of the American College of Surgeons Chicago October 18 1904.

In every country the family doctor is a natural sprout from the soil. His profession is almost as old as the day break of time. He bled the ancient Egyptian, blistered the knight of the Middle Ages and poisoned the arrow of the Iroquois. He has been preserved in fiction, pickled in the drama, spiced in romance, and peppered in satire but nowhere was he so pronounced a character as in the old South. He knew politics but was not a politician. He looked upon man as a machinist viewing an engine but he was not an atheist. He cautioned health and flattered sickness. He listened with more patience to an old woman harping on her trouble than to a man in his prime relating his experience. His books were few and the only medical journal found in his office was a sample copy. When his gathered lore failed him, he was wise in silence.

At no place along the numerous roads traversed by old doc was there a signpost with a finger pointing toward the attainment of an ultimate ambition. No senate house, no woolstack of greatness waited for him. The chill of foul weather was his most natural atmosphere and should the dark night turn from rain to sleet it was then that he heard a knock and a "Hello" at his door. Down through the mucky bottom land and up the first hillside flashed the light of his gas lamp striking responsive shine from the eye of the fascinated wolf. The farther he had to travel the less likely he was to collect his bill. Usury might sell the widow a cow for no one expected business to have a daintiness of touch, but if old doc sued for his fee he was met even by the court with a sour look.

Blessed be the memory of old doc! He may have been poor in scientific knowledge, but he was rich in human insight. He may have been awkward in handling test tubes, but he was adept in handling patients. He knew, without learning it from lecture room or laboratory the subtle interdependence of mind and body. He was a psychoanalyst before the days of psychoanalysis. His sick rooms were secular confessionals in which he practiced a rare priesthood. His deficiencies were many but, according to his lights, he was an apostle of the art of medicine. Modern medicine must perfect his technique and widen his knowledge but it must not lose his spirit. Old doc, brought down to date, gives us a doctor who knows how to link the learning of the laboratory to the life of the patient, making that learning bring cure to men in the shadow of sickness and caution to men in radiant health.

For a long time old doc held the field. The art of medicine was dominant. And then the winds of a new critical and scientific spirit began to blow across the world. That spirit crossed all frontiers and on unseen wings flew through the closed doors of dogmatism and self-satisfaction everywhere until the whole of modern life was touched by it, medicine along with other fields. Today the science of the study of disease is slowly but surely transforming the world of medicine.

I shall not undertake to analyze or assess the innumerable studies, the varied sciences, the extensive researches, and the new techniques that

are today playing a living part in the evolution of modern medicine. And for two good reasons: first, because I am a stranger to the detailed facts of modern scientific medicine, second, because it would be an old story to you, even if I were qualified to tell it. I purpose tonight a simpler undertaking, and one a layman may, perhaps, enter upon without too great presumption.

I want to deal with just one question: What are the implications of this Medical Revolution for the average man in the private practice of medicine and for the schools and hospitals in which we are training men for the private practice of medicine?

I think we may find a fruitful lead to an answer to this question by considering the new Medical Revolution in the light of the old Industrial Revolution. For, it seems to me, the private practitioner of the art of medicine, face to face with the organized promotion of the science of medicine, is in very much the position of the handicraftsman, when, at the dawn of the Industrial Revolution, science introduced machine power into industry. The parallel is, I think, both accurate and illuminating.

The handicraftsman, both in himself and in his system, had many virtues and many values that society could ill afford to lose as it moved over from a pre-machine to a machine economy. In like manner, the private practitioner of the art of medicine, both in himself and in his none too systematic system, has many virtues and many values that medicine can ill afford to lose as it moves over from a pre-scientific to a scientific basis.

Because there was not enough industrial statesmanship among the handicraftsmen the evolution of industry got out of hand, many of the rarest values evolved by the handicraftsmen through the centuries were lost, and a vast high-powered industrial machine subjected the handicraftsmen to a ruinous competition they could not meet. In like manner, unless adequate medical statesmanship is brought to the direction of the present Medical Revolution by the men now in the profession we may lose many of the rarest values evolved by the old practitioners of the art of medicine, and it may happen that a vast high-powered medical machine, under the sponsorship of industries, insurance companies, and governments will enter the field and subject the private practitioners of medicine to a ruinous competition they will be unable to meet.

Let me indicate the direction in which it seems to me, things will inevitably move in





The heads of industries that blight the health of their workmen, educators who forget the body in the training of the mind, grocers and cooks who are salesmen and servants only, architects who have not learned that a building must be useful before it can be beautiful in a social sense—all these will some day be regarded as biological traitors. Here, again, we have the beginnings, in fact, more than the beginnings, of a vast popular movement respecting health and disease, which when fully under way, will not worry excessively about its effect on the private practice of medicine.

In short there are today lying about us many if not most of the raw materials for a vast system of state medicine or its equivalent in the corporate medical activities of industries, insurance companies and the like. As a general principle I dislike to see any activity fall into the hands of government—whether it be an activity of business or labor or agriculture or the professions—if such activity can be administered equally well or better by the trade or profession to which the activity logically belongs. Society forever faces the dilemma of choice between an internal and an external control of its fundamental services. I prefer an internal control, not because I am a reactionary who grows hydrophobic at the suggestion of government control. I have rarely been accused of that. I prefer an internal control for the obvious reason that, as modern society becomes increasingly complex and technical, the man on the job should be better equipped for the job than the man on the sidelines. It is I think, an intelligently progressive policy to consider government control of fundamental services only when internal control breaks down or plays truant to its responsibility. In the light of this principle I raise the question: Is private medicine to be superseded by state medicine or its equivalent?

The answer to this question will I think depend entirely upon the quality of medical statesmanship displayed by the medical profession during the years immediately ahead. It would be presumptuous for me to undertake to discuss anything save the broader aspects of the medical statesmanship to which it seems to me, the present phase of social insight and medical evolution challenges the private practitioners of medicine in its varied approaches to the care of health and the cure of disease. I speak not from an expert's knowledge but from a layman's observation. A few things however seem fairly obvious.

First under adequate medical statesmanship the private practitioners of medicine will excel

industries, insurance companies, and governments in their zeal for the promotion of preventive medicine. That is to say, the private practitioners of medicine will deliberately set out to educate their clientele to look to physicians primarily for the care of health rather than for the cure of disease. Unfortunately, the American people still look upon doctors mainly as experts to be called in emergencies. On account of this shortsightedness of the American people, doctors actually have a vested interest in ill health instead of a vested interest in good health. The prevailing attitude of the people toward doctors actually puts a premium upon disease rather than upon health. In the main doctors still secure their income from curing sick folk, not from advising well folk how to keep well. The tendency toward retaining doctors as health advisers is growing, but it is still a tiny tendency that affects the total health problem only slightly.

Do not misunderstand me. No one in America recognizes more fully the wasteful insanity of making doctors healers of disease rather than protectors of health than does the doctor himself. But until the American people are educated out of an attitude that obliges doctors to make the major part of their income from attending cases of sickness, our only hope of a healthier nation, unless we are to go over bag and baggage to state medicine, lies with the unselfish doctor who will consciously reduce his income by foisting upon sick patients health advice that may keep them from falling sick again. And, mark you, he must usually give this preventive advice as a side issue to medical attention, which means giving it to a sick patient whose mind at the moment, is more upon his immediate plight than upon the future regulation of his habits. The doctors are not to blame one tenth as much as the people are. Despite the health agitations of enlightened self interest and social insight, our national motto seems to be: Millions for pills but not one cent for prevention!

If the American mind could be so changed that the average American would look to his doctor for the care of health rather than for the cure of disease, a wholly new order could be established in the world of medicine. Into the fascinating details of the profound changes that could, in the light of such an attitude, be made in the practice of medicine I shall not now undertake to go. I shall content myself with suggesting that this change in attitude toward doctors can be brought about only in one or the other of two ways. First, it can be brought about as a result of a

medicine in the absence of far sighted medical statesmanship on the part of the medical profession. One of the major marks of our time is an increasing interest in the prevention of disease. A growing determination to rid society of the waste and inefficiency due to disease is becoming one of the social passions of the period. This determination is heading up into certain very definite public and quasi public movements that have intimate implications for the medical profession. Let me suggest the more obvious source of three such movements.

In 1909 it was estimated that at all times in the United States 3,000,000 persons were seriously ill. This meant an annual loss of 13 days per person on account of illness. It was then estimated that 42 per cent of this illness was preventable. About 3 years ago—when I last looked carefully into this situation—we had cut this loss from 13 to something between 8 and 9 working days per person. At that time about 42,000,000 persons were classed as gainfully employed in the United States. When these lose something over 8 days each year from illness, disabilities, and non industrial as well as industrial accidents, it means that these 42,000,000 gainfully employed persons face an annual loss of nearly 350,000,000 working days. Disease must bear the blame for a staggering loss of working time. Of the 500,000 workers who die each year, it is considered probable by dependable authority, that one half of the deaths would prove postponable by adequate medical supervision, by medical examination, by health education and by community hygiene.

Going on the conservative assumption that the average life—aside from its human values—is worth to industry, say, \$5,000, and estimating the cost of special diet, nursing and medical attention needed by a sick man at the very conservative figure of \$3.00 a day, the economic loss from preventable disease and postponable death, in the situation I have described, reaches the staggering total of \$1,800,000,000 annually borne by those gainfully employed in the United States. On the basis of the most dependable research available, it is estimated that this loss could be cut to a point where, over and above the costs of prevention, a balance of something near \$1,000,000,000 annually could be left in the pockets of the working population and industries of the United States.

It is obviously inevitable that the growing enlightenment of labor leadership and the intelligent self interest of industry should set about seeing to it that this unnecessary loss is

stopped. Much has already been done by industry, but as yet only the surface of possibility has been scratched. And you may be sure that when the forces of labor and the forces of industry get fully under way in a determined effort to lift from labor and industry this burden of loss from preventable disease and postponable death, they will not be concerned primarily with the effect of their program on the private practice of medicine.

There is again the rapid development of adventures in disease prevention and life prolongation by the big insurance companies. Here, as in industry, a powerful private economic interest is a driving force back of a socio medical program. And here, as in industry, you may be sure that the insurance companies will not be primarily concerned with the effect of their program on the private practice of medicine.

In addition to these powerful private economic interests, making for a vast disease prevention program, there is a growing social conscience respecting the issues of health and disease, a growing social conviction that the health of the social order is importantly interlocked with the health of its citizens.

We seem to be drafting a new definition of treason. The American public is about ready to agree with Lord Palmerston that for every death from typhoid somebody should be hanged. We may, in time, make the first test of every industry its reaction upon the health of its workmen. No industry is profitable to the nation if it stunts the bodies and shortens the lives of its workmen and some day we shall look upon the head of such an industry as a traitor to the state, although he may be a highly respectable citizen whose favorite indoor sport is tracking down radicals who have spoken disrespectfully of the Constitution. Some day we shall let every educational system by its reaction upon the health of its students. We shall insist that its buildings, its curricula, its teaching methods, its social organization shall conspire to conserve the student's health while he is in school and teach him to preserve his health after he leaves school. Some day we shall realize that an architect whose buildings are not conducive to health is a bad architect despite the beauty of line and mass he may have captured in his structures. And it may not be fantastic to think that some day we shall insist that grocers and cooks be licensed to pursue their crafts under the requirement that they know something about the relation of the selection and preparation of foods to the health of the American family.

psychologists, with their mental tests would grade our children as if they were apples from the orchard or corn from the field. When they had found those they thought were culls, they would deny to them all educational opportunity except a little manual training or something of that sort. The ethnologists would herd all of us into a series of racial pens, as if we were Holsteins or Poland Chinas on a stock farm, and stir up all sorts of jealousy between the inmates of the Nordic pen and the Alpine pen and the Mediterranean pen. And there are the biologists. They're the most dangerous of the whole lot."

His special dislike of the biologists interested me and I asked him for details.

'The biologists,' he said, "would like to have us go back to barbarism and let natural selection weed out all the weaklings so the race as a whole could grow strong. The biologists don't give a continental for the individual human being. They care only for the race and their care for the race means cruelty to the individual human beings that happen not to measure up to their notion of a first class man. Biology simply kills sympathy and tenderness and love in the man who follows it."

Be a little more specific,' I urged.

'Why haven't you noticed the way the biologists sneer at charity? Science has simply killed in them the ability to appreciate the humane motives that sustain the vast philanthropic and social enterprises which, as I see it, prove that we are growing more civilized, that we are displaying sympathy, tenderness, and love for the unfortunates. The biologists tell us that our charity keeps alive an incredible number of persons who ought to be dead. And they say that the result of keeping these people alive is a deterioration of the whole race. They say frankly that charity is setting a premium on sick bodies and blundering minds and actually subsidizing shiftlessness. Don't you see the inhumanity of their position? If we follow the biologists, we shall have to let our weak-bodied and weak-minded babies die, sterilize and stigmatize our diseased, and, if we are logical, chloroform our old folk who might produce weak babies or weak ideas that would retard the progress of the race.'

There was nothing to be gained by allowing him to go on. He had stripped his sentimental mind naked. It seems to me that he and his sort completely misinterpret the motive and misunderstand the method of the authentic scientist who is dealing with human and social issues.

'I venture to suggest that you are wrong,' I said to him, 'all wrong, from start to finish. You

are wrong in saying that science makes a man less sympathetic and tender in his consideration of the unfortunate. And you are wrong in saying that the biologist's program of race improvement means a cold, cruel, and impersonal treatment of the individual human being. On the contrary, it seems to me that science is laying the foundations for a new tenderness, a deeper understanding, and a more fruitful sympathy than sentimentality has ever produced. If I were an unfortunate I would rather trust my fate in the hands of a really informed scientist than in the hands of a merely public spirited philanthropist. Just because he would understand my plight better, the scientist would deal with me in a more genuinely sympathetic spirit. And I believe that the most humane undertaking of our time is a statesmanlike program for race improvement."

'The new tenderness of science! Ha!" he exclaimed. "Are you trying to be humorous?"

I could see that although he dealt almost entirely in generalizations of the widest sweep, generalizations would never convince him. I attempted specific illustration.

'Suppose,' I said, 'that you are boarding a street car. The street car is manned by a slow-witted conductor, a man against whom the cards of both heredity and environment have been stacked, a man badly born and badly reared. He lacks that grace of temper that well born and well reared folk display. He is a congenital grouch. He slams the door unceremoniously on your foot. And, just to add to the pleasantness of the proceeding, he starts the car with a sudden jerk that sends you sprawling on the floor of the platform of the car before you have had time to extract your imprisoned foot from the door. Now I suggest that if you really know what modern science has to say about that conductor, if you know what biology and psychology have to say about such badly born and badly reared folk, you are in a better position to deal sympathetically and understandingly with that incident than if you had only a fund of general sweetness and sympathy upon which to draw. The scientist will realize the vast impersonal forces of heredity and environment that have made the conductor the grouch that he is. You condemn modern science for being impersonal, but here is an instance in which only an intelligently impersonal consideration can produce tenderness and sympathy. And, just in passing I should like to say that many of the most public spirited men I know—men who give all sorts of time and money to philanthropic causes, are the most severe, unreasonable, and unsympathetic men I know

deliberately organized and persistently promoted nation wide educational campaign on the part of the private practitioners of medicine to change the attitude of their clientele toward doctors, to induce the American people, as I have said, to look to doctors for the care of health more than for the cure of disease. Second, it can be brought about by a vast high powered machine of state medicine or its equivalent.

This transformation of attitude toward doctors is bound to come. It lies with the doctors themselves to say by which way it shall come. If the medical profession does not display adequate sensitiveness to social values and adequate statesmanship in meeting social issues and itself lead and administer this transformation it will inevitably be led and administered by industries, insurance companies and governments.

Second, under adequate medical statesmanship, in such states as do not have great cities in which the sheer volume of work to be done develops great hospitals and draws together great practitioners of the varied arts and sciences of medicine, the private practitioners of medicine will foster rather than fight the development of state supported medical and hospital centers where the rank and file of men engaged in the daily practice of medicine may keep constantly in touch with the latest results of research, where they may periodically refresh their knowledge and perfect their technique through lectures and clinics, and where they may find an extent of equipment and an expertness of assistance which the average practitioner may not be able himself to afford or to administer. In such states adequate medical statesmanship will create and sustain such centers of training, research and assistance for the further reason that the very existence of such centers of scientific medicine will give to the whole medical profession of the state and to its clientele a psychological sense of assurance that any emergency may be met with out having to cross the continent—all such centers being developed as supplements to, not substitutes for, the practicing medical profession of the state.

Third, under adequate medical statesmanship the rank and file of private practitioners of medicine will see to it that the medicine of the future swings neither to the extreme of an unscientific art of medicine nor to the extreme of an artistic science of medicine. If in his role of liaison officer between science and suffering, the doctor can effect a happy union of the science of medicine with the art of medicine, he will be meeting and mastering, in his field, the dominant

issue of our time, which is: How can we make science and its myriad specialisms the servant rather than the exploiter of mankind? In his fusion of art and science in the field of medicine the doctor will be making a major contribution to that humanization of science upon which, more than all else, the continuity and quality of western civilization depends. He will be helping to naturalize the social and philanthropic urge in a scientific age. How difficult, as well as desirable this enterprise is, I can best emphasize by trying to reconstruct a conversation to which I was a party some years ago.

When I was editor of the *Century Magazine*, I had a friend who lived around the corner and dropped into my library now and then for a talk. He was a merchant of menaces. He was forever pursued by some peril. One night he came to me greatly disturbed by what seemed to him the menace of science.

"Science," he said to me, "is curing and clothing our bodies but it is killing our souls."

"How?" I asked.

"Well it's this way," he said. "You see we aren't guinea pigs or chemicals in a test tube. We're human beings. And that's what the modern scientists have forgotten. They've lost the human touch. They've become cold, cruel and impersonal. It wouldn't matter so much if they stuck to their guinea pigs and their test tubes, but lately they have begun to swarm out of their laboratories and to meddle with all sorts of human problems. And every time they touch a human value they blight it. They are laying their unholy hands on religion, on politics, on education and even on the sacred relations of the home. Biologists, psychologists, and ethnologists are now presuming to tell us how to raise our families, run our governments, conduct our schools and reform our churches. And you're guilty of having aided and abetted them by opening the pages of the *Century Magazine* to some of them."

He mentioned J. B. S. Haldane, Bertrand Russell, F. C. S. Schiller, and a dozen others.

"These men," he went on to say, "illustrate the grave danger of approaching human problems from the point of view of modern science. They're cold, cruel and impersonal. I tell you, you can't handle the human problems of the church and the school and the home without sympathy, tenderness, and love. And these are the things that modern science is killing."

"Go on," I urged.

"See what would happen," he said, "if we allowed the scientists to dictate our affairs. The

session? No other profession makes quite so many demands upon a man in the way of richness of personality, breadth of intellectual interests, catholicity of sympathy, and expertness in the techniques of human relationships. Aside from the demand for scientific knowledge of disease and its cure that the medical profession makes upon the doctor, there are other demands that might well discourage any man from entering practice.

The great doctor must know almost as much about the social order as the sociologist. This is necessary because the varied forces—political, social, economic, industrial, educational, religious—that march across a nation, making its mind or marring its spirit, register their effects in the lives of the doctor's patients. The more the doctor knows about these forces that make the atmosphere in which men's minds and bodies live, the more intelligently can he trace effects to their causes, and the more wisely can he counsel his patients.

The great doctor must know almost as much about the mind as the psychologist. This is necessary because even the most materialistic scientist admits that there is a subtle relationship between mind and body that the doctor of the body dare not overlook, for when he does overlook this relationship a thousand quacks rush in to capitalize his oversight.

The great doctor must know as much about the subtle art of counselling as the priest.

The great doctor must refuse to be party to the ironic paradox of commercializing a profession just when the professionalization of commerce begins to dawn.

The great doctor must decline to tear his specialism out of the living texture of the whole medical fabric. He will not allow the noble science of surgery, for instance, to degenerate into a merely higher carpentry.

And finally, the great doctor must be able to distinguish between Hippocratic ethics and hypocritical etiquette in matters professional.

in their relation to their servants and to cases of individual need. I would be willing to wager that research would show a higher average of considerate sympathy among modern scientists than among modern sentimentalists."

"That's your guess," he said "but the fact remains that all of the proposals of the biologists and eugenicists for race improvement are cold, cruel, and impersonal in that they say that charity does more harm than good. What would they have us do? Should we let our poor unfortunates starve and freeze just to get the unfit out of the way and to leave the world to the fit? Shall we turn the world into a vast breeding farm for thoroughbreds? What will become of the human values that we have come to associate with civilization?"

"The trouble seems to me to be," I suggested, "that the philanthropists and the scientists too often fight each other when they should collaborate. And that is just what the real scientists are working toward. Of course a few camp followers of science, who have picked up a few points of modern biology and missed its spirit, are suggesting the sort of inhuman things you say. But they, along with you are missing the whole point of the authentic scientist's attitude toward charity. The authentic scientist knows that, while the philanthropist who pitches biology overboard becomes a utilitarian, the biologist who pitches philanthropy overboard becomes a brutalitarian. It is only when a man joins the technique of the laboratory with the temper of love that he becomes a social statesman. And that, I submit, is precisely what the authentic scientist is striving to do. You are judging modern science by a few merry andrews, mountebanks, and charlatans who have stolen the patter of the laboratory in order to give an air of importance to their sensational journalism. You have, I think, completely misread the biologist's attitude toward philanthropy. But maybe the biologists are a bit to blame. Maybe they haven't taken enough care to see to it that we laymen understand them. Some distinguished biologist should write a little book to explain just what place tenderness and sympathy and love have in the great adventure of race improvement."

"I am afraid the trouble would be," he said, "that you couldn't find a biologist who thinks charity has any place in what he would call social statesmanship."

"Again I am sure you're wrong," I said. "I am sure that any really great biologist would say two things about charity. First, I think he would

recognize that sympathy, tenderness, love and their attendant amenities are qualities that belong to first class men and women. And he would not be so blind as to miss the point that any eugenic program would defeat its own end if it began by crushing out of the first class men and women these qualities of sympathy and tenderness and love that they now display in their charities. Any such heartless program would set up forces of tradition and social heredity that would in time rob the superiors of these very important qualities of superiority. A great biologist, despite some of the swashbucklers in the lunatic fringe of the biological fraternity, will never counsel us to let our unfortunates starve and freeze. He knows that a man who hasn't enough sympathy to respond to the needs of an individual human being cannot be counted upon to respond to the needs of a whole race. As someone has remarked, men who will not respond to hygienics are not very likely to respond to eugenics."

The biologist is not asking us to stop our charity. He is only asking us to rationalize our charity. The spirit of modern science, unless I misread it, tells us to go on taking care of our unfortunates, but it asks us to set in motion forces of enlightenment and to use every legitimate device for seeing to it that these unfit and unfortunate do not go on outbreeding the fit and the fortunate, as they are doing today. The spirit of modern science simply wants us to see the folly of an unintelligent coddling of the unfit in a manner that will make certain that our children, with a diminishing birth rate in their families, will have to take care of an ever increasing number of unfit. For if we do not make science the ally of our social service, by the sheer mathematics of the case a time will come when there will not be enough fit to take care of the unfit. And then we may realize that our unintelligent sympathy has turned out to be the most cruel thing in the world."

I am sure I did not convince my friend, but at least he helped me to clarify my own mind regarding the crucial importance of humanizing the application of the results of scientific research. It is just this humanization of science, this marriage of scientific procedure and social passion that the doctor, who is at once scientist and artist effects.

And now may I end by saying how sinfully I envy you who tonight prove by your entrance into the Fellowship of the American College of Surgeons that you have in some distinguished sense answered the high challenge of your pro-

With these ideas in view, the Board, through an especially appointed agent working under the direction of the chairman and the secretary of the Board on Traumatic Surgery and guided by the Director General has made surveys of conditions in the Oklahoma oil fields, in the city of New York and in Chicago. These surveys include a study of the question with relation to the competency and efficiency of all parties interested in the care of the injured. The program of the Board will be based in part upon the results of these surveys, summaries of which have been published in the *Bulletins* of the College for June and September, 1929.

#### MEDICAL EDUCATION

It was realized that all real progress in the care of the injured depends upon improvement in the teaching of this subject and in emphasis placed upon it in the curricula of the medical schools, with postgraduate courses as well. At the instigation of the Board on Traumatic Surgery, this subject was presented at the 1928 meeting of the American Association of Medical Colleges held at Indianapolis and a committee of that organization has been appointed whose duty it is to see that emphasis is placed upon the teaching of the subject of traumatic surgery in the curricula of the surgical departments of the medical schools. The future influence that this will have cannot be overemphasized.

#### LIST OF APPROVED TRAUMATIC SURGEONS

It is realized by the Board that a degree in medicine or a state license to practice medicine does not indicate competency in major traumatic surgery. An attempt is being made by the Board to form a list of competent traumatic surgeons throughout the United States. Information concerning these surgeons is obtained from numerous sources and is being accumulated at the College and indexed on cards. Some thousands of these cards have already been prepared as an initial step in the preparation of a list of those who eventually may be recognized by the College from the standpoint of competency to practice traumatic surgery.

#### CONTACTS

The Board on Traumatic Surgery has been in intimate contact with groups of all agencies interested in the care of the injured, namely, prac-

ticing surgeons, compensation carriers, employers of labor, employees, industrial medical clinics, compensation commissions, hospitals, hospital clinics, and organizations of the medical profession interested in traumatic surgery.

#### SECTIONAL MEETINGS

Sectional meetings of the College have been held in a large number of the states of the Union and in Canada. These meetings occupy two days of discussion on scientific subjects, hospital programs, and a public meeting. At all of these some phase of traumatic surgery has been the subject of discussion. Personal contacts by members of the Board with local men in the various states have been established and an interested co-operation has been secured from these men who have been made familiar with the activities of the College in reference to traumatic surgery.

#### DEPARTMENT OF HOSPITAL ACTIVITIES

The Department of Hospital Activities of the American College of Surgeons is in daily contact with about 3,000 hospitals of twenty five beds and over, in the United States and Canada, and 1,919 of these hospitals appear on the approved list of the American College of Surgeons. All of these have been made familiar with the work of the Board on Traumatic Surgery, and advice has been furnished to them as to methods pertaining to organization and equipment for improved care of the injured. The value of the co-operation of this Department with the work of the Board on Traumatic Surgery cannot be overestimated on account of its intimate personal contact with hospital administrators, hospital trustees, and surgeons.

#### CONCLUSION

The activities of the Board, up to the present time have been of an educational formative and research character—seeking for a firm foundation for its more definite constructive program. Some phases of the constructive program have already been outlined and put into effect.

A 'Standard for Medical Service' has been evolved and is being perfected to be required of industries, hospitals, indemnity carriers and others desiring recognition and approval by the American College of Surgeons.



# CONFERENCE ON TRAUMATIC SURGERY

## OPENING REMARKS<sup>1</sup>

FREDERIC A. BESLEY, M.D., F.A.C.S., MAURKIN, ILLINOIS  
Chairman, Board on Traumatic Surgery

THIS is the third meeting which has been conducted by the Board on Traumatic Surgery of the American College of Surgeons to consider the principles involved in and to exchange thoughts and ideas relative to, the absorbing subject of traumatic surgery or the care of the injured. The first meeting was held at Detroit and the second at Boston.

In preparing the program that is to be presented today no difficulty was experienced in securing men interested in both the scientific and the economic sides of the question to participate. The keen interest that has been shown implies a common bond of sympathy and a unity of purpose in securing better medical and surgical care of the injured.

During the past three years the efforts and

activities of the Board on Traumatic Surgery have been directed toward the building of a firm and substantial foundation of education regarding all phases of this intricate situation and today at this meeting it is hoped and believed that the corner stone will be laid for an enduring superstructure which will furnish resources for the practical and the actual achievement of better care for the injured, for we are not yet so thoroughly informed but that further information is welcome and desirable.

Obviously, this building involves the correlation of many interests and circumstances which fortunately, do not conflict and it is believed that today's discussion can be successful in bringing to a fruitful issue the practical improvement in all departments of traumatic surgery.

## ACTIVITIES OF THE BOARD ON TRAUMATIC SURGERY<sup>1</sup>

BOWMAN C. CROWELL, M.D., CHICAGO  
Secretary, Board on Traumatic Surgery

DURING 1926 the Board of Regents appointed a Committee on Traumatic Surgery and a Research Group of this Committee to study the question of improvement of the care of the injured. This Research Group made a report to the Committee, and the Committee made certain recommendations to the Board of Regents of the College on October 26, 1926 in which was established a Minimum Standard pertaining to the practice of traumatic surgery. This standard was adopted by the Regents. At this time a Board on Traumatic Surgery was appointed for the purpose of carrying on these studies and making recommendations to the Board of Regents with a view to improving service in the field of traumatic surgery. Since that time the Board through the central office of the Department of

Clinical Research, has been actively pursuing this subject. Its activities have been along several lines:

### SURVEYS

In order that the Board on Traumatic Surgery might have first hand information and make its own study of the practice of traumatic surgery without bias or prejudice which might arise from information obtained from any of the parties interested in the care of the injured a series of surveys of actual conditions has been carried out. This has been done with the object in view also of arriving at definite conclusions as to the important points in which there exist deficiencies in the care of the injured. Only with such information can a rational program for improvement of the care of the injured be formulated.

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 24-25, 1929.

the most careful study before premature adoption. If we were concerned only with the care of those injuries readily recognizable as serious when first seen, our problem would be confined to adequate first aid and immediate transportation to a qualified surgeon in an efficient hospital. When we consider the total number of industrial accidents, however, the serious, urgent emergencies are found to be rather rare and for economic reasons nearly all of the less serious injuries require treatment in relatively close proximity to the place of employment. And what of that vast volume of injuries less serious originally, in which subsequent and often serious complications develop? Each injury has the potentiality of danger no matter how trivial originally. We know that the primary treatment during the first day or week often determines the final result, what disastrous results often follow failure to recognize promptly a skull fracture with latent symptoms, a perforated viscus from an abdominal injury, or a deep-seated hand infection.

How important, therefore, is the local traumatic surgeon and how essential that he be of good training, demonstrated ability, sound judgment, and integrity. For in him is vested the responsibility for the care of a huge majority of the injuries in industry, 90 per cent of which must be treated in the vicinity of the factory. He determines the primary diagnosis and mode of treatment and watches carefully for subsequent complications. Open reduction of fractures and operation for skull fracture are rarely indicated in proportion to the total number of fractures and head injuries which the local surgeon sees but the stiff joints, lame backs, results of infection and numerous other conditions cause functional impairment and lost time which run into a huge total.

It is fundamentally essential therefore that intelligent skillful care be immediately available

to the patient in the district in which he works. Careful selection of the local surgeon is necessary to guarantee such care. Chosen as the result of this selection, the local surgeon should not be hesitant to seek consultation and should be glad to receive constructive criticism. But he rightfully expects the privilege of assuming responsibility in proportion to his ability.

The injured patient's welfare, individually and collectively—in the present and in the future—always will be closely linked with the quality of traumatic surgery, to elevate the status of this branch of surgery, it must become increasingly attractive to the best type of future doctors, and to attract this desired type, competence and ability must be recognized.

The conclusion is obvious: the arbitrary practice adopted by some indemnity companies of indiscriminately taking over patients irrespective of the local surgeon's ability is open to just criticism when we carefully scrutinize all of the factors affecting the present and future welfare of the injured. This procedure is unnecessary if the following fundamental principle is closely adhered to, namely, that the responsibility for the care of the injured from the very beginning until discharge be restricted to the competent. This applies alike to local surgeon, consulting specialist, and chief surgeon. Under such conditions the patient's welfare is safeguarded. To accomplish it will require much education of indemnity companies, employer corporations, surgeons, and the public. But the increasing recognition of the importance of the crippling casualties in industrial and civil life, and the public's sense of deep obligation to the injured employees who are given practically no jurisdiction as to the type of care they receive, will be powerful factors in improving the quality of traumatic surgery and in guiding the injured into the hands of those surgeons qualified to insure efficient service.

THE RELATION OF THE SURGEON TO THE INDEMNITY COMPANY<sup>1</sup>

FREDERICK W SLOBE M D CHICAGO  
 Secretary Chicago Society of Industrial Medicine and Surgery

ANY study of the relation between the surgeon and the indemnity company should be based on the influence such relation ship has on the patient's welfare. We must continually keep in mind our common obligation, namely, the relief, cure, and rehabilitation of the injured in the shortest possible time. Everything else must be subservient to that purpose. Although several economic commercial trends are a vicious menace at times, we must not allow our attention to be distracted by steadfastly keeping the patient's welfare as our objective, many of the disquieting tendencies of commercialism will be overthrown by the sheer force and irresistible appeal of conscientious, efficient service.

There are certain factors and tendencies in the relation between indemnity company and surgeon which have a definite effect on the quality of service to the injured and which, therefore, merit close consideration.

It is not difficult to ascertain that the patient is bound to suffer from the unfortunate practice of price cutting. When voluntarily practiced by the surgeon, it is usually indicative of a subterfuge to cover up incompetence. When insisted upon by indemnity companies, it indicates a lack of realization that the cost per visit means little as compared with the total bill that the total bill is of little significance as compared with the result obtained that cheap rates when matched up with poor results are most costly and that bargaining for surgeons usually defeats its own purpose. Such tendencies do not lodge the patient in the best hands and an inferior grade of service results.

Quite similarly, a very deterrent effect upon the patient's welfare arises from the adoption of indiscriminate contracts. When based upon a percentage of the premium, the surgeon literally gambles with the insurance company. His remuneration is almost invariably so absurdly low that becoming disgruntled he finds it difficult to enter into his work with that requisite spirit and keen interest so essential in stimulating his best efforts. Injuries come to be viewed in the aggregate as part of a factory's hazard instead of each patient being studied as an individual problem.

The injured employee is not a commodity but a vital organism quick to react unfavorably to

any economic trend which affects his surgical care adversely. Hence, both his immediate and ultimate welfare are jeopardized unless the surgeon receives adequate remuneration for services performed. This danger is eliminated if the surgeon is paid on a fee basis, he is then compensated for what he does—no more and no less.

During the past year we have experimented with several contracts and it is our firm conviction that contract practice is usually prejudicial to the best type of service, that the surgeon is almost invariably underpaid and that the field of traumatic surgery would be gradually undermined thereby. This may not apply, however, to certain salary arrangements provided the remuneration is adequate.

Another great factor influencing the quality of the patient's treatment lies in the relation between the local surgeon and the indemnity company's medical department with its chief surgeon. If the patient is to receive intelligent consideration by the insurance company, it is most essential that its medical department be independent with full authority in handling all strictly medical situations. The chief surgeon, as well as being a recognized leader in traumatic surgery, should be a man of human understanding and diplomacy. All of the local, district surgeons should be selected by him instead of by the non-medical claim department. The basis of such appointment should not be the fee per dressing, or the fallacious system of statistical average costs of bills, but rather the surgeon's ability, training, honesty, and judgment. The chief surgeon is entitled to be the head of the entire medical organization instead of merely the claim department's consultant. The district surgeon then becomes a part of a medical system instead of a pawn in the hands of a claim man.

The entire medical department of an indemnity company should be of such high caliber as to inspire the confidence of the local surgeons. The patient's prospects are not bettered unless the indemnity company's medical department has something superior to offer.

The fixed policy followed by some companies in insisting that all hospital patients and all ambulatory office patients who are not working be referred to the chief surgeon is an experiment with such far reaching results that it merits

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 14, 1929.

were he in private practice There is not much advancement for him except in salary The management may change ideas may change, the business may be sold, slumps may come and sometimes the industrial surgeon finds himself without a job or income However, private practices have been lost and other physicians have been forced due to circumstances, to break up pleasant associations and change locations and fields of activity and it would be strange if this did not occasionally happen to the surgeon in industry

But this is enough of the pessimistic side The real status of the industrial surgeon is exactly what he makes it His status and success in industry depends upon his being able to sell himself, and his ability to the people of that industry, both management and employees, and to work in harmony with them and his co practitioners in that community If he renders service, if he sells health if he is everlastingly at it I question in industry a willingness to part with such a man Sometimes we become so egotistic, so filled with a sense of our own importance that we do not see how industry can get along if we are not there to explain what a 'cholecystitis' or a 'nephritis' is It is then that our status or relation to industry becomes warped and we do not give to the employer or to the employees our best service

As to qualifications the industrial surgeon must like industry and folks who work He must enjoy working with the producers and builders in a nation of producers and builders He must be able to think of production and waste in reference to his own department

Time lost because of sickness or injury is waste Healthy employees working full time means production Production by the industrial surgeon is not men sick at home or in the hospital but in the shop under healthy working conditions He must have knowledge of the healthy man and how to advise him to stay healthy He will need the mechanical ability of a toolmaker for his fracture work His training in surgery must be the very best for his job is repair work and the lacerated injuries which come to him are infected and in the average factory of the metals trades these are legion In plain English this industrial surgeon should have a better training than any of us physicians ever did have for he will need it all

When an industry is going to build an engine, be it gas steam or crude oil a corps of engineers

is hired—an electrical engineer on the magneto, batteries and wiring, a mechanical engineer, an engineer on combustion, a metallurgist or chemical engineer—and all work on a piece of machinery that when complete a boy of grade school education can run And let no one lead you to believe that industry picks out the mentally lame, halt, and blind when it goes out for these engineers Industrial managers do not want, nor will they employ the engineer whose general knowledge of the various branches of engineering is good They want and get the man who knows one line and is a leader in that line and they are not concerned about the expense They employ the most highly trained the most scientific men to do, not a multiplicity of engineering feats, but rather just one and do it well I know an engineer whose sole job is high speed work, another whose job is Diesel engine construction, confined entirely to heavy duty work, an electrical engineer who confines his duties to the making of magnetos I could cite more examples but these are enough to demonstrate the point that industry is employing highly trained, skilled technicians to build a mechanical apparatus, and it would be the height of folly to suppose that these same employers would be lax in their selection of their industrial surgeon This industrial surgeon must work with these highly educated and trained men, he must work with the management, and the majority of his patients come from the foundrymen, blacksmiths, the mechanics and the laborers who follow out the orders and ideas of the first two groups

I have known instances of firms which wished to build and maintain a working force of the most complicated pieces of living mechanism that the world has ever produced and which secured engineers whose only qualification was their legal right to put the letters 'M' and 'D' after their name When all industries apply the same test or comparable tests to their selection of men to head their engineering and their human maintenance departments they will get results because they will get qualified men It is man power that runs industry Healthy man power is efficient If industry wants that and I believe it does, it will be repaid by investing in the best there is

The status of the industrial surgeon is and will be measured by the service he gives his qualifications by the results he obtains

## PRESENT STATUS AND QUALIFICATIONS OF THE INDUSTRIAL SURGEON<sup>1</sup>

C F N SCHRAM M D, BELLEVILLE, WISCONSIN

President American Association of Industrial Physicians and Surgeons

THE present status of the industrial surgeon depends entirely upon the point of view. Some of those inside the medical profession regard us as unfair competitors, some as merely too lazy to work up a private practice, and some regard us as merely lucky. The impression seems to be that we get a big salary with no office collection, secretarial, or other expenses which are usual in the practice of medicine, and it is probably this latter feature that is uppermost in the minds of those who consider our status lucky.

As to our being lazy—well, a lazy man is a lazy man but I do not believe there is a lazy job. One may be lazy and slothful on any job and I know that some medically trained lazy men have for short periods held down a chair (borrowing a phrase from our universities) in industry, but the competition is too strong, the dissemination of knowledge along medical and surgical lines too great for the managers of industry to countenance for long the employment of a lazy physician. I know of none in the American Association of Industrial Physicians and Surgeons.

Unfair competitor—rather a unique appellation, which is never applied to ourselves, but without inquiring into the details or circumstances surrounding any given case or cases it can be applied to the other fellow with impunity and the physicians and surgeons in industry, because of their special position in the surgical field and because of a feeling of apprehensiveness in regard to the future economic stability of the practice of medicine have frequently been accused of disobeying this tenet of the ethical code.

I just referred to the field of medicine and surgery as being economically unsound. This applies as I see it to the great bulk of the practice of medicine as it is carried on today by the general practitioners. The indications of this economic unrest are made manifest almost daily in the daily press, the medical journals and the trade magazines through editorials and syndicated news articles in regard to state medicine, pay clinics, university hospitals and so called endowed research laboratories. The reason for this agitation is not hard to find. The cost of sickness has increased until there is an economic demand for a lowering of these costs. The physician has not been the gainer to any marked extent in this in-

creasing cost of sickness but he has received the discredit for it. Generally speaking the physician has not responded to this adverse criticism by solving the problem of increasing cost of sickness and I am not alone in my feeling that it is his job.

The shoe pinched when laymen attempted to solve this problem by endowing hospitals, clinics and laboratories and when some industries employed medical and surgical staffs for the complete care of their employees, in a few instances extending this care to dependent members of their employees' families.

I have called attention to this economic aspect of the practice of medicine because I know that when things are unstable and when there is an attitude of dissatisfaction and apprehensiveness we are quite prone to criticize. I presume that it is for this reason that the physician in industry has received his share of the adverse criticism.

One example will be enough to refute such an accusation. In a certain city an industry employing a surgeon on full time, paid to local physicians during the year 1928 \$1,070.00. Hospital bills of employees or members of their families \$940.00 was guaranteed and \$,000.00 was loaned to employees on account of sickness, a goodly percentage of which went to pay physicians' bills. Besides this, 600 cases were referred directly to the local physicians. But at the request of the company this industrial surgeon had cared for during 1928, 46 cases of injury not occurring in employment. These 46 cases charged for at the regular rates would have amounted to \$150.00. To repeat, this industry put out through the jurisdiction of this surgeon, \$1,000.00 directly to ten different local physicians, loaned \$,000.00 more on account of sickness and referred 600 patients to local physicians and surgeons and the firm and the surgeon were severely criticized for their special interest in 46 minor cases.

The interest of employer in employee as portrayed by this illustration can and is being duplicated in almost every industry throughout the United States and Canada and it well demonstrates the importance which industrial leaders are placing upon the man power in their shops today.

The industrial surgeon is less settled and sure of his position in the community than he would be

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 14-18, 1929.

The examination of the prospective employee then becomes a physical appraisal for the purpose of making it possible for industry to know the condition of the various new labor units which it brings within its walls and to place them suitably. This statement omits the unassailable declaration that industry should not employ individuals who through employment constitute a menace to themselves to others, to property, or to service.

The physical examination of the prospective employee, it is to be hoped, when carried out at the hands of industry in a proper fashion, may become one of the most valuable of our public health and health maintenance agencies. As individuals are examined, and their several standard factors uncovered and appraised, it is apparent that if their physical condition does not preclude employment, there exists the potential urge to correct the ordinary impairments.

In a general discussion no attempt should be made to classify the various types of impairments other than to say that they may be grouped as minor and major, and correctable and non correctable. Properly I believe, in any case the minor impairments should be acceptable under certain restrictions. The major correctable impairment is as a rule not a bar to employment in some capacity while the major non correctable one is worthy of much concern. Which impairments are included in the several groups, it is quite impossible to discuss within the time allotted to me. Classification varies with the industries involved and the requirements within these respective industries. I wish merely to make the point that, under proper influence of industrial supervision it should be possible to make evident to accepted employees the real necessity for correction of all impairments that are correctable. It is highly probable that the common cold and most of the other upper respiratory infectious diseases owe either the power of their bacterial attack, or the lessening of the forces of resistance, to open focal avenues along either the breathing apparatus or the food tube.

When we consider that included in the minor impairments are most of the air passage and gastro-intestinal foci of infection and further when we consider the ease with which many of these foci are eradicated, or the bacterial flora inhibited or abolished, it is apparent at once that there is a vast field of justifiable preventive practice opened wherever medicine finds its proper place in industry. There is still a long way to go before we approach anything like the control of the correctable minor impairment question as it involves the respiratory or the gastro intestinal

apparatus. As for the major correctable impairment, we know that many of the anatomical as well as the physiological dyscrasias may, through the proper application of surgical or medical means, be partially or wholly overcome.

This leaves for consideration, then, the large class of persons who possess impairments that are non correctable and of such type and degree that they are placed in the major category, and who, therefore are often excluded from employment. Their impairments, while of a considerable degree of gravity, have at the benevolent hands of nature been so kindly adjusted in the phenomena of compensation that such persons still have, if properly treated, the possibilities of relatively long life and remunerative productiveness.

In this latter group may be mentioned impairments—such as cardiac, cardiovascular, renal, post tuberculous, chronic gastro intestinal, metabolic, special sense, genito urinary—also new growths and impairments of the bones, joints, and skin.

To enumerate the specific types in each of the above mentioned groupings would require an elaboration not possible within the time limits of this paper. However, the case of cardiac impairment will serve as a fair illustration of the point of view taken with respect to employment of the individual with a major non correctable impairment.

Probably no class is more often refused employment than that with valvular heart disease because, even in the incomplete physical appraisal that industry makes, the valvular murmur is at least a positive sign and one which the average examiner with average hearing, can detect. In most instances applicants are rejected without regard to the type, transmission, or position of the murmur and quite generally without due regard to the signs of decompensation. We not infrequently see the vigorous looking full blooded, well nourished individual, with a poor myocardium and impending decompensation accepted for employment, while the thin, poorly nourished individual with a distinct murmur at the apex systolic in time, but with a good myocardium and no decompensation, is only too generally refused employment.

It is to be remembered that the physical examination of the prospective employee for economic and administrative reasons, intersects into medical understanding a new conception of the physical examination. Primarily, the industry is in business for the purpose of producing a product or rendering a service to be sold at a profit. The medical element is only incidental and, while its public relations value, as well as its contribution

## PRE-EMPLOYMENT AND PERIODIC HEALTH EXAMINATIONS IN INDUSTRY<sup>1</sup>

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THE physical examination of the prospective employee is, unfortunately, still looked upon by many executives, as well as by certain of the medical profession, as a means for making it possible in their respective industries to obtain labor that is going to be subject to the smallest amount of impaired production and absenteeism due to potential or active disease. It would seem that there are still to be found doctors and lay people who talk and think 100 per cent mechanistically. When the employer anticipates going out into the labor market, his state of mind with respect to his fellow beings who are going to contribute the labor is just the same as though he went into the machine shop to purchase machine equipment. We often hear the statement that man is a machine. In a sense this may be true as we think of his physical operation. Nevertheless, in pinning the statement down to personalities, it is seldom that we find either executive or employee ready to be classified with lathes, punch presses, or screw making machines. The human body may work mechanically and chemically according to the several laws known regarding natural processes. But a human being taken out of the community and put into an industry is not in the same category with the machine. It is true that many of the activities of maintenance and operation of machines are duplicated in man; you can overhaul the human being and clean him outside as well as inside. He gets lubrication fuel and water. As a result, work is done. His contribution to the product or service may be computed fairly definitely in terms of energy and consumers may be charged for it. But again I insist he is not entirely a machine—only in part are his activities machine like.

A lathe, a punch press or a screw making machine undergoes conditioning similar to that which maintains the human operative. The machines are cleaned, lubricated, have a source of energy applied, and thus do work just as is the case with a human being. The analogy runs as a striking parallel throughout the entire story up to the question of replacement. The machine cannot of itself replace parts, while, in a measure, there is replacement in the human being. Neither does a planer or a stamping machine, no matter how long employed, ever own the business.

The living entity that is involved in this argument is a definite one and establishes the man as something apart and infinitely above the machine. The majority of human beings in the pursuit of life, liberty and happiness, can obtain necessary remuneration only through work, and also they have a certain right to expect, as proceeds from this work, something beside food, clothing, and shelter. There are many of the good things of the world which lie just beyond the absolute necessities, and whose attainment can come about only through an increase in the character, extent, and refinement of the several phases of endeavor. Thus an available field lies at the door of all who can and will work.

When a man goes to an industry for work he generally goes because he needs a job and hopes that some job needs him regardless of his physical qualifications. Industry does not approach the prospective employee with inducements of various kinds, unless the individual has something worth while to sell. The romantic formulator of the Declaration of Independence stated that all men were created free and equal. We know that this is true only in a measure. Unfortunately, environment, heredity, poor food, living habits, ignorance, and disease have forced upon a certain portion of our community bodily impairments for which, in the main, they cannot be held responsible. The sources of these impairments are no respecters of persons; they invade all grades of society and of course it is manifest that employment in some form or other is necessary for the majority of persons. A part at least of the obligation to provide employment belongs to industry because of its immediate or remote responsibility for the environmental conditions.

As medical science develops and becomes more exact in diagnosis and examination, we find that the physically perfect individual is fast becoming a rarity. We can generally uncover some physical fault in everyone. Thus it is that industry can never attain the place where it employs only the perfect man or perfect woman. It becomes a self-evident fact that we must accept for employment individuals with certain impairments. In the industrial world there are various grades of physical requirements and into these certain individuals with impairments can and should be fitted.

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 24, 1939.

THE ORGANIZATION OF AN INDUSTRIAL MEDICAL DEPARTMENT<sup>1</sup>VOLNEY S. CHENEY, M.D., CHICAGO  
Medical Director Armour & Company

THE problem of organizing a medical department in large industries, those of 500 or more employees, is much easier of solution than the problem presented by small industries that cannot support a full time medical man. Because of this division of industrial medical work into two large classes it is impossible to cover the subject of organization with its many varying aspects in a short article such as this must necessarily be. We must therefore deal in generalities and with the fundamentals only of industrial medical service.

Why should there be an organized medical department in any industry? Have not the general practitioners and the general surgeons contended that there is no such thing as industrial medicine and surgery? Have they not argued, and are still arguing, that they can do the work of the industrial physician just as efficiently as he? That in industrial surgery is traumatic surgery and any good general surgeon can do traumatic surgery?

That any good surgeon can do traumatic surgery even industrial traumatic surgery, we shall not deny, but traumatic surgery constitutes not more than one third of the work that an industrial surgeon is called upon to perform, so upon whom can industry depend for the performance of the other two thirds? Not upon the general practitioner who has had little or no experience or training in the five other fundamentals of an industrial health service but upon the industrial physician who has had both training and experience in the medical and non medical requirements of his position. Then again, of two men whose education and technical ability are equal, is not the one whose work is one third traumatic surgery, better qualified to do it than the one who sees only an occasional case?

Before we can intelligently plan or organize anything we must know what its object is to be, what function it is to perform and what its purpose is.

What is the object of an industrial medical department? Health service to the employee and under this broad term is included the care of the industrially injured. What function is it to perform? To supervise and care for the health of the employee. What is its purpose? Humanitarian? Yes, by all means should the humanizing element be its guiding influence. Uthitarian? Yes, in the sense of usefulness otherwise it cannot perform

its highest function of service. Economic? Yes, although this is usually hard to demonstrate to the satisfaction of industry's executives. Philanthropic? No! at least not in the present day sense of the word which conveys the idea of organized charity. Altruistic? Yes! It never should be actuated by sordid motives. Paternalistic? Emphatically, no! An industrial medical department should never usurp the functions nor transgress the prerogatives of the general practitioner. It should never tend to pauperize but rather by education and friendly (fraternal) advice, assist the employee to help himself in all matters pertaining to health.

When an industry has decided that there is a need for health service in its organization, the first and most important task is to secure a capable physician to direct the work, to make a survey of the plant to ascertain its specific health hazards and its essential health needs, and then to submit a plan with recommendations for meeting that particular industry's health requirements to an executive who has general authority over the entire industry. The work and plan of the medical department should never be hampered by being placed directly or indirectly under the control of a layman who is the head of a department whose activities are actuated by purely mercenary motives, it should thoroughly co-operate with but never in any way, be subservient to the casualty or insurance department. As the scope of a medical department's work is general and co-operative with all other departments in the organization the medical officer should be responsible only to an executive with general authority.

In choosing a physician to serve as medical director employers should exercise the same care as used in selecting a man for any other important technical position in their organization. They should not assume that physicians, just because they are physicians are thereby qualified to organize or direct an industrial medical department. As the value of such a department depends primarily upon the doctor's ability to inspire confidence he should be selected with more consideration of his personality than of his professional competency but this also should be of the highest order. Adequate salary so rare in industrial medical departments, should be paid in



to the industry, is constantly being more appreciated by executives, nevertheless the element of cost enters rather largely into the organization of any plan for physical examination.

The pre employment physical examination, then, is not a hospital or diagnostic clinic survey. Its final purpose is to determine whether an individual is employable under the conditions we have mentioned and to do so with the least possible expenditure of time and cost.

Aside from the advantage of the rejection of hazardous persons or of placement according to physical abilities, the initial pre employment examination has no other function than to provide an urge for the correction of impairments. Once the industry is entered, if no further physical appraisal is made, a real opportunity along the lines of health conservation has been lost. To justify from all angles the pre employment examination, it should be coupled with physical surveys at certain times in the course of the employment. In individuals with no discernible impairments should come under the schedule of the yearly health survey whereas those with major or minor non correctable impairments should submit themselves for examination at intervals to be determined by medical advice. As a result of the physical findings, it should be a simple matter to demonstrate the need of a consultation with the individual's medical adviser.

In the light of our present understanding the care and correction of such impairments is not within the scope of the field of endeavor of the industry. The medical talent may be capable. Nevertheless, industry, since it is not in the business of practicing medicine, is not justified in adding to the cost of its product or service the cost of providing for adequate medical or surgical care of prospective employees or employees with minor or major correctable or non correctable im-

pairments. With respect to the correction of impairments the medical department should act in the capacity of a clearing house of advice as to capable and adequate medical and surgical sources. In all instances in which advice is given with reference to medical, surgical, dental, or hospital care, opportunity for multiple choice should be insisted upon.

As a public relations activity and as an economic contribution, no greater good can be imagined than industry's co-operation in attempting the solution of the problem presented by the unfortunates who, because of the major nature of their impairments and for no other reason, are refused employment. Such institutions as the American Heart Association, the National Tuberculosis Association, the National Safety Council, the American College of Surgeons, and the American Medical Association have made and are making splendid contributions in their endeavor to find this solution and thus far much has been accomplished. Nevertheless, industry and these publicly minded groups have a long way to go, not only in the education of their own medical personnel but in that of management. A sick man is rarely considered an asset but a man who has been sick and recovered, even though with physical residues, who is co-operative and who knows how to maintain health is oftentimes a more reliable, loyal, and appreciative employee than the individual who has never been ill. As we consider the monumental contributions to society, literature, art, science and music we are astonished to find that in many instances they have been made by chronic invalids and frequently the greatest contributions have been made during their periods of extreme discomfort or even serious illness. The physically imperfect individual deserves and must have real consideration when he seeks industrial opportunities.

those problems. There can be no doubt that such a difference exists and the claim of the physician in industry to being a specialist is not based upon his possession of any peculiar medical knowledge but chiefly upon his knowledge of non medical things.

In common with all other physicians he should possess a good education, honesty, tact and judgment, a thorough training in the fundamentals of his profession, and a hospital service of not less than 2 years. Along with these he should also have had several years of general practice in which he maintained a close connection with public health agencies and studied preventive medicine, community health problems, and activities or in lieu of this a special course covering these subjects. He must have a general knowledge of industrial relations including employment methods, labor turnover, job analysis, apprenticeship, pensions, insurance, rest periods, absenteeism and welfare problems and a working knowledge of the workmen's compensation law of his own state and of other states, also if his industry is national in scope. Other essential qualifications are a thorough knowledge of working conditions and their influence upon the health of the worker, of occupational diseases, accident prevention, heating, lighting, ventilation, water supply, housing conditions and community health problems. Thus we find that the industrial physician combines with his medical knowledge and experience certain other attributes peculiar to the sanitary engineer, safety engineer, employment manager and community health officer. It is the lack of this knowledge which handicaps the new medical man coming into the industrial field. It is the lack of this knowledge which makes it impossible for the general practitioner or general surgeon to do the industrial physician's job as effectively as he himself is able to do it. It isn't every physician that can make a success of industrial medicine. Many young men enter it thinking it an easy way to make a living but they soon drop out when they realize or are forced to realize that their unpreparedness and lack of special knowledge of industrial problems makes it impossible for them to occupy any other than a very minor position in the industrial medical field.

I am convinced that the successful industrial physician like a poet is born and not made. He must be endowed with that certain peculiar attribute mostly inherent and partially the result of environment, that we call personality. A per-

sonality that attracts and one that invites and inspires confidence. A personality based upon a true love and sympathy for his fellowmen. His attitude of friendliness toward the injured employee must be absolutely sincere and not assumed. He must be able to put himself in the place of the injured employee and treat him as he, himself, would want to be treated. He must be a man of large, sympathetic understanding, capable of finding and reaching that point of contact which all persons possess no matter how hard booted they appear, and which brings him into close accord with the employee.

You say that all physicians should possess these qualities in order to attain success. That is true, but the industrial physician should have them in the *nth* degree.

When employing a physician for industrial work, first consider his personality, second, his education, third, his technical ability. With two or more men whose education is equal, give the preference to the one possessing unusual personality over the ones possessing unusual technical ability. Technique, through practice and experience may be acquired, but personality is something that must be born in you, or at least develop with you from infancy. It can rarely be acquired or changed in later life.

What I have said about the qualifications of the industrial physician applies equally as well to the industrial nurse, with the exception that her knowledge of the non medical subjects need not be as thorough. Being a woman she is naturally more sympathetic than a man which augments her innate gentleness.

Adequate training for the personnel of an industrial medical and nursing service consists in obtaining a medical or nursing education of the highest type of developing an unusual amount of technical ability of acquiring considerable knowledge of certain non medical subjects that are peculiar to industry and of possessing a personality that is the embodiment of sincere love for your fellowman.

To organize an adequate medical department in an industry first carefully select the medical director who most possesses the qualifications I have enumerated pay him a salary comparable with that of other men of like education and technical ability in the organization and allow him really to direct the activities of the department without too much interference from the supervising executive.

order to attract a high class man. It should be no less than that of the chief counsel, chief engineer, chief chemist or the chief of any of the other technical departments. The conservation of the machine power is considered good business management and is supervised by a high salaried official. The conservation of the man power that runs the machines should be of paramount importance. Mr. Magnus W. Alexander, managing director, National Industrial Conference Board says: "The Management which follows the short-sighted policy of employing the medical man it can obtain most cheaply is sure to get as much ability and professional skill as it is willing to pay for and no more and it may even find that by such a policy it has done more harm than good. In industrial work second rate physicians are a menace as great as or even greater than are second rate executives of any other type."

The medical department of an industry is, almost without exception, an index of the economic value the management places upon health service rather than what the medical officer desires it to be. If better medical service is desired in industry it is not so much a problem of the physician in industry as it is of the educating of the management to the value of such a service. Many large industries have already proved that the more extensive the health service rendered the better it pays.

A complete health service program for an industrial medical department consists of

1. The care of industrial injuries. This is the primary function of all industrial medical departments and is the only activity they have in common in large and small plants.

2. The examination of applicants for employment or employees transferred within the plant not for the purpose of rejection but as a means for selective placement.

3. Preventive medicine as featured by the consideration of problems of plant hygiene and sanitation, including particular observation of groups of workers exposed to specific hazards.

4. Frequent examination of workers known to be sub standard or in need of medical supervision and the periodic examination of all other employees at least once a year.

5. The education of workers in matters pertaining to health.

6. The guidance of workers in securing necessary and competent medical service both diagnostic and remedial.

Upon the management will rest the responsibility for determining the scope of the work to be instituted by the medical department. This in a

great measure will depend upon the size of the industry. If treatment of industrial injuries was the end of industrial medical service, standards of personnel could be fixed with accident frequency and severity rates as the basis to work upon. But there are the other activities previously mentioned, some of almost as great importance, and the more of them the medical department undertakes, the larger the personnel must be. In an industry of 500 employees a complete health program would require the full time service of an industrial physician and with the addition of a nurse 1,000 employees could be efficiently supervised.

Shall the personnel of the medical department be upon a full time or part time basis? This is a question upon which there is a diversity of opinion. A combination of a full time medical director with part time medical assistants offers a satisfactory arrangement in plants of sufficient size to warrant a complete medical health service. This plan assures, at the same time, medical service of a high quality and adequate administrative supervision. Detached medical service as in use in small industries is, with rare exceptions, purely a surgical service. Obviously the employer who desires a broader range of medical service to include physical examinations, etc. must regularly employ a physician upon either a part or whole time basis depending upon the scope of activities desired.

The number of physicians and nurses making up the personnel of an industrial medical department must vary with the size of the plant and the scope of the medical activities desired by the management. The quality and character of this personnel should never vary and should always be of the highest type.

To specialize in industrial medicine requires a knowledge of certain social economic and administrative problems related to industry that are not in the medical curriculum. Many physicians think that industrial medicine and surgery is nothing more than traumatic surgery and consists entirely of the treatment and care of injuries and requires no special training or knowledge other than that acquired by the general practitioner in obtaining his degree. Traumatic surgery constitutes only about one third of industrial medical work in those industries that have a complete health service. Its proportion is larger in the smaller industries. The difference between a physician in general practice and an industrial physician consists of the latter's appreciation of the problems of industry and the application of the art and science of medicine and surgery to

who will have the case under continuous observation, it is extremely dangerous to put a plaster cast on a broken limb in the first few hours, especially if the cast is not cut.

In the initial treatment of a fractured limb for transportation, the Thomas splint has played a role with which all modern surgeons are quite familiar. Before the war many practitioners had no recollection of having seen the Thomas splint and comparatively few, excluding those who had studied in Liverpool had seen one actually employed in the treatment of a fracture of the lower limb. The late Hugh Owen Thomas of Liverpool, was a great benefactor of humanity. A treatise based on his work has recently been written by Sinclair.

As our knowledge of the Thomas splint is a by-product of the late war we might well turn to our Medical Department, U S Army for a further study of Transportation of the Injured. Surgeon now in industries who served in training camps during the war may well apply their lessons in "Training Regulations" on the litter, the ambulance, the field litter carrier.

Surveys have shown that transportation of injured employees is provided by one or more of the following means: (a) private ambulance service situated near the plant; (b) taxicab, if the injury is not serious enough to justify the use of an ambulance; (c) company automobile kept at the plant headquarters ready for emergency service; (d) employee's automobile which may be situated conveniently near the scene of the accident; and (e) street cars and buses. The last named are commonly used by ambulatory patients who return to the physicians for treatment and redressings.

Arrangements have not been made for an efficient promptly responding transportation service in many industries. Where various means of transport are depended upon and where none of the vehicles are under the control of the industry, delays are often encountered where promptness is most desired. This delay not only prevents prompt emergency treatment which is often vitally important to the welfare of the patient but it also prolongs the pain and exposure which may extend the period of ultimate recovery.

It is a common practice in many industries to authorize mediocre treatment near the scene of accident rather than develop safe and efficient transportation of the injured to a competent surgical service which includes adequate facilities for diagnosis and efficient treatment.

Railways have found it practicable and advisable from legal, surgical and economic stand-

points to transport injured cases, including fractures, to a central surgical service which may be made to provide efficient care.

Plant ambulance service may be provided in two ways: one owned and operated by the plant, or a so called public ambulance. The value of the service depends on its availability, the time required to reach the injured, and its cost. We use plant owned and operated ambulances at some plants and public ambulances at others. The public ambulance charge is based upon a flat trip rate or call. At one of our plants where we operate our own ambulance and have an average of 27 calls per month, it costs \$7.27 per call. This includes a yearly depreciation charge on the ambulance of about five hundred dollars per year. At another plant where we use a public ambulance the cost is \$3.50 per call. The average time for the plant ambulances to reach the injured is 4 minutes and for the public ambulance it is 12 minutes.

Table I shows cost of plant owned and operated ambulance for period of 3 years at the South Chicago plant of the Illinois Steel Company.

TABLE I—COST OF PLANT OWNED AMBULANCE

Number of calls in 1918	
Illinois Steel Co.	327
Other Companies	73
Co t.	\$2351.83
This includes \$340.00 depreciation on ambulance	
Number of calls in 1927	
Illinois Steel Co.	90
Other Companies	14
Co t.	\$379.53
This includes \$395.00 depreciation on ambulance	
Number of calls in 1926	
Illinois Steel Co.	311
Other Companies	14
Co t.	\$2372.96
This includes \$340.00 depreciation on ambulance	
Average cost 1 per call 3 years	\$ 2.
At Cary, Indiana a public ambulance service shows average cost per call	\$3.50

While transportation of injured frequently is thought of as consisting of the handling of the severely injured patients, it may well be considered in cases of minor injuries. In a large plant which employs 5,000 to 15,000 men a vehicle for bringing the slightly injured cases to a dispensary or hospital where a surgeon will care for them has many advantages. In such plants the buildings are generally cattered over a large area extending in either direction a mile or several miles, but frequently so-called first aid stations are common.

It seems that the transportation of patients with minor injuries—such as foreign bodies in the

TRANSPORTATION OF THE INJURED<sup>1</sup>

GEORGE G. DAVIS, M.D., F.A.C.S., CHICAGO

Chief Surgeon Illinois Steel Company

**I**N discussing the subject of transportation of the injured, one finds that there are a number of allied subjects to be considered synchronously. The preparation of the patient for transport is important. The type of transportation itself must vary to suit the existing conditions. In discussing the subject of the transportation of injured in industrial accidents we must first analyze the existing conditions and their economic relationship, and then we may ask the question, "Is there any room for new thought to improve the existing conditions or to introduce new methods to further aid the injured and to lessen the economic burden?"

All surgeons agree that nothing in the way of first aid is of more importance than the protection of the patient from infection and further injury while he is being transported to the hospital or other place of permanent treatment.

In this preparation the first essential is that the patient, whether he be transported ten blocks, ten miles, or one hundred miles be so fixed that he will do himself no harm. This applies especially to patients with simple fractures for if immobilization is not brought about in such a case much harm may be done.

It is a cardinal rule that every broken limb should be lined up as nearly as possible in its normal axis and immobilized, this can almost always be done. There may not be at hand a box or splint, to be sure, but it requires small skill to extemporize something that will do the work. If the fracture is below the knee, a good safe temporary support can be made with an overcoat blanket, bed quilt or pillow on the outside of which a board, walking cane, or umbrella may be fastened by bandages, handkerchiefs, or strips of any material at hand. One of the very best and most comfortable temporary splints for fractures below the knee can be made with an ordinary pillow brought up around the sides of the limb and snugly bandaged in position either with or without an outside board splint.

Fractures above the knee can be immobilized with a folded blanket or quilt or bed bolster, over which a board or fence rail, from the waist line to below the foot, is fastened at the waist line in the crotch, just above the knee and ankle with bandages, handkerchiefs, or strips of torn sheets or quilts. Such material can be secured under

nearly all circumstances. The main thing to bear in mind is that under scarcely any conceivable circumstance is it justifiable to move such a patient until the fracture is comfortably immobilized. Otherwise a simple fracture will almost certainly become a complicated and possibly even a comminuted and a compounded fracture.

In railroad accidents particularly, the fractures are not always simple, but are often compound in all grades of severity, so that the less one does the better if the patient is to be put in the hands of a competent man in a few hours. One should straighten out the limb, coaptate the fractured bones the best he can without touching them and cover the wound with the cleanest and best material at hand. If one cannot get gauze one can get freshly laundered soft linen or cotton goods, or even towels with which to protect the wound from further infection while the patient is being carried to the place for permanent treatment. It is extremely dangerous to attempt to clean compound fractures under such circumstances. Unquestionably, the safest method is to apply first aid as described for the danger is nearly always immensely increased if an attempt is made to do anything more radical.

It is rarely almost never, necessary to use a tourniquet in crushing injuries. It is infinitely better to let them bleed a little. The danger of hemorrhage is not to be compared with that of applying a tourniquet and letting it remain in place for 2 to 10 hours. A surgical dressing should be applied snugly and nicely and the patient sent to the hospital or wherever he is going if he can get there in a few hours.

Small lacerations and punctured wounds are dressed and unfortunately frequently the patients are not sent to the hospital. It is a fashionable thing now for some "first aid" person simply to pour a little iodine into the wound or smear it on the wound and when that is done he believes that all indications and necessities have been amply met. Preferably all such patients should be sent to a dispensary, or hospital and treated by a surgeon. If a limb has been fractured, it should be emphasized that first aid should consist in the application of a temporary splint and that the permanent dressing should not be applied until the patient is treated at the hospital. Except in the rarest instances and in the hands of an expert

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 14-15, 1919.

who will have the case under continuous observation, it is extremely dangerous to put a plaster cast on a broken limb in the first few hours, especially if the cast is not cut.

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Cost	\$2372.86
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It seems that the transportation of patients with minor injuries—such as foreign bodies in the

eye, abrasions, lacerations, infections—to a plant dispensary with a surgeon in charge insures the patient better service and the company less loss of time. It also makes possible the securing of a complete record of the case which is often of great medico legal value.

#### CONCLUSIONS

Patients with severe injuries should be transported to a dispensary or hospital where proper surgical treatment can be given. Only the minimum treatment should be given before the patient is transported. Transportation of minor injury cases to a dispensary or hospital and treatment by a surgeon are preferable to first aid treatments by first aid persons throughout the plant.

#### REFERENCES

1. SALADERS BACON. Preparatory treatment for transportation of the injured. *South M J* 1916 IV 54.
2. SULLIVAN MELBICE. The Thomas Splint and its Modifications in the Treatment of Fractures. New York. Oxford University Press 1927.
3. WAR DEPARTMENT. The Litter. Medical Dept. S G O Training regulations No 403-30.
4. WAR DEPARTMENT. The Ambulance. Medical Dept. S G O Training regulations No 403-60.
5. WAR DEPARTMENT. The Field Litter Carrier. Medical Dept. S G O Training regulations No 403-90.

#### DISCUSSION

Dr W E DEEKS General Manager Medical Department United Fruit Company New York. Transportation of the severely injured on the plantations of the United Fruit Company in the tropics presents somewhat different problems from those in the United States.

There are practically no transportation facilities other than those afforded by the railroads except in the port towns where motor car ambulances are available to convey the patients from the railroad terminals to the hospitals in which all the severe traumatic cases are treated.

First aid treatment is given where the accident occurs, by dispensers, farm superintendents, overseers, timekeepers or gang foremen to all of whom first aid appliances are made readily accessible. Railroad ambulance cars are immediately summoned to transport the injured to the hospital, or in cases of great emergency the nearest locomotive is commandeered to effect speedy transportation.

It is interesting to note that the native laboring population does not suffer the same degree of shock from severe injuries that prevails among the laboring population in this country, and moreover they appear to be more resistant to ordinary wound infections. On the other hand owing to the wide spread prevalence of anemia as a result of blood and intestinal parasites constitutional infections and malnutrition convalescence is often delayed.

First aid measures preparatory to transportation of the more serious traumatic cases to the hospitals do not differ materially from those utilized elsewhere.

## GROUP MEDICAL SERVICE FOR SMALL INDUSTRIES<sup>1</sup>

C D SELBY M.D. F.A.C.S. TOLEDO OHIO

THE science of medicine has become very complex. Individual physicians no longer are expected to cover the whole field. Hence the increase in the number of specialists and the formation of groups. With this development has come industrial medicine, which though not a specialty is an adaptation of medical knowledge and practice to the needs of industry.

It may better be defined as the science the theory, and the practice of medicine as applied to the prevention and alleviation of sickness, injury, and physical deterioration among industrial workers. It includes not only the practice of medicine in all of its branches—diagnosis, internal medicine, surgery, orthopedics, etc.—but preventive medicine as well. The physician in industry is a health officer and a practitioner.

With this conception it is apparent that no individual doctor can cover the whole field in industry any better than he can in general practice. Large and wealthy industrial establishments recognize this limitation and overcome it by providing for the services of specialists to supplement the normal functions of their medical departments. Small establishments, on the other hand, are unable to make such provision for the care of their employees because of the relatively great expense.

There are then these two reasons for the formation of groups to serve small industries: (1) industrial medicine is too broad a field for the individual practitioner, and (2) adequate service is too expensive for the average small industry. Therefore a scheme has been devised for the furnishing of complete medical service for small industries at a

<sup>1</sup>Presented before the Conference on Traumatic Surgery. Clinical Congress of the American College of Surgeons. Chicago. October 14-8 1929.

nominal pro rata cost and that scheme is, in a word, group practice

Group practice in industry may be discussed from several standpoints those of the employer, insurance carrier, employee and physician. As a physician, I prefer to discuss it from the standpoint of the employee for he is the beneficiary of the service, and its value is measured by the degree to which he is benefited. Any other measure is apt to be fallacious. Any other approach may be biased. As measured by this standard, the aims of medicine in industry are

1 To assist the employee to obtain a kind of work he is physically, and possibly mentally, fitted to do. This requires physical examinations of new employees and a knowledge of job requirements.

2 To so guide him and surround him with safe guards that he may do his work without jeopardy to health and physical fitness. This requires re-examinations and inspections of working conditions.

3 To so treat him for injury and sickness arising out of his work that he will lose the least possible time and ability.

In other words, the purpose of medicine in industry is to assist the employee in maintaining and possibly improving his productivity and earning power or wages. Although productivity and earning power are much the same, the employer is interested in the former, the employee in the latter. Products are what the employer wants; wages are the employee's demand.

So while we as physicians are primarily interested in the health and fitness of the workman, both he and his employer are probably more directly interested in profits and wages and are inclined to measure the value of the medical service by its effect upon those economic factors.

After all, the distinction is trivial. We may approach industry from the standpoint of health, the employer and employee from the standpoint of profit and wages, but the result is the same. Better health and working conditions contribute to greater profits and higher wages. Nevertheless, the group that will serve industry best must be in sympathy with the purpose of industry, though the matter of profit and wages need not dominate its actions. The group must be so constituted and organized that it can treat injuries with a minimum of lost time and impairment, offer such advice to both employer and employee as will tend to cut down losses of time and material, and must consider all medical problems from the effect they may have upon continuous and profitable employment.

Even so slight an affair as the time required for dressings is important. The group must be situated so as to offer the most expeditious service in this connection, centrally located so as to make it quickly available to the maximum number of employees it serves. If the number warrants in any one plant, dressing stations may be provided where dressing can be done at a given time daily.

Disabled patients must be returned to work at the earliest possible moment consistent with good treatment. Mutilated patients must be treated with their ultimate disposal in mind. Where can they best be placed upon their return and can special treatment fit them for some class of work other than that prior to accident?

Inspections must be made regularly in the factories served, followed by conferences with those responsible and recommendations followed up.

Physical examinations and re-examinations must be made at the group clinic or in the factory, if provisions are adequate, always with the thought in mind that employment must not be hazardous to either the one examined or his fellow workmen. Nor must the fact be ignored that the information the doctor gains through the examination may be of value to the employee and properly belongs to him. Has he heart disease or is he otherwise afflicted, the employer should know it.

The group should be prepared to make researches into occupational diseases or occupational conditions in relation to disease and in times of epidemic to institute appropriate measures.

A group organized to carry on the foregoing program must be under the leadership of a physician who has a broad knowledge of industry and medicine. The minimum of activity must comprise general and orthopedic surgery, industrial hygiene and plant service. On the staff should be enough physicians proficient in these branches to do the work, the number depending upon the number of industries. In the beginning it might be possible to combine general with orthopedic surgery, and industrial hygiene with plant service. Assistance in the less active branches of roentgenology, dermatology, the specialties of the eye, ear, nose, and throat, dentistry, and the laboratory sciences can be obtained as needed from proper specialists allied to the group but not affiliated with it. It is presupposed that these are sufficiently acquainted with industry to correlate their work with that of the group. The development of its practice will determine the expansion of the group, just where specialists shall be absorbed by it and how rapidly the active staff shall be increased. Those are details that work themselves out as the practice of the group grows.



eye, abrasions, lacerations, infections—to a plant dispensary with a surgeon in charge insures the patient better service and the company less loss of time. It also makes possible the securing of a complete record of the case which is often of great medico legal value.

### CONCLUSIONS

Patients with severe injuries should be transported to a dispensary or hospital where proper surgical treatment can be given. Only the minimum treatment should be given before the patient is transported. Transportation of minor injury cases to a dispensary or hospital and treatment by a surgeon are preferable to first aid treatments by first aid persons throughout the plant.

### REFERENCES

1. SAUNDERS BACON. Preparatory treatment for transportation of the injured. *South M J* 1916 ix 54.
2. SPOCLAIR MELRICE. *The Thomas Splint and its Modifications in the Treatment of Fractures*. New York: Oxford University Press, 1921.
3. WAR DEPARTMENT. *The Litter*. Medical Dept S G O Training regulations No. 403-50.
4. WAR DEPARTMENT. *The Ambulance*. Medical Dept S G O Training regulations No. 403-60.
5. WAR DEPARTMENT. *The Field Litter*. Medical Dept S G O Training regulations No. 403-90.

### DISCUSSION

DR W E DEEKS, General Manager Medical Department United Fruit Company, New York: Transportation of the severely injured on the plantations of the United Fruit Company in the tropics presents somewhat different problems from those in the United States.

There are practically no transportation facilities other than those afforded by the railroads except in the port towns where motor car ambulances are available to convey the patients from the railroad terminals to the hospitals in which all the severe traumatic cases are treated.

First aid treatment is given where the accident occurs, by dispensers, farm superintendents, overseers, timekeepers or gang foremen to all of whom first aid appliances are made readily accessible. Railroad ambulance cars are immediately summoned to transport the injured to the hospital or in cases of great emergency the nearest locomotive is commandeered to effect speedy transportation.

It is interesting to note that the native laboring population does not suffer the same degree of shock from severe injuries that prevails among the laboring population in this country and moreover they appear to be more resistant to ordinary wound infections. On the other hand owing to the wide spread prevalence of anemia as a result of blood and intestinal parasites constitutional infections and malnutrition convalescence is often delayed.

First aid measures preparatory to transportation of the more serious traumatic cases to the hospitals do not differ materially from those utilized elsewhere.

## GROUP MEDICAL SERVICE FOR SMALL INDUSTRIES<sup>1</sup>

C D SELBY, MD, F.A.C.S. TOLEDO, OHIO

THE science of medicine has become very complex. Individual physicians no longer are expected to cover the whole field. Hence the increase in the number of specialists and the formation of groups. With this development has come industrial medicine, which though not a specialty is an adaptation of medical knowledge and practice to the needs of industry.

It may better be defined as the science, the theory, and the practice of medicine as applied to the prevention and alleviation of sickness, injury and physical deterioration among industrial workers. It includes not only the practice of medicine in all of its branches—diagnosis, internal medicine, surgery, orthopedics, etc.—but preventive medicine as well. The physician in industry is a health officer and a practitioner.

With this conception it is apparent that no individual doctor can cover the whole field in industry any better than he can in general practice. Large and wealthy industrial establishments recognize this limitation and overcome it by providing for the services of specialists to supplement the normal functions of their medical departments. Small establishments on the other hand, are unable to make such provision for the care of their employees because of the relatively great expense.

There are then these two reasons for the formation of groups to serve small industries: (1) industrial medicine is too broad a field for the individual practitioner and (2) adequate service is too expensive for the average small industry. Therefore a scheme has been devised for the furnishing of complete medical service for small industries at a

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 12-13, 1929.

TRAUMATIC SURGERY IN THE CURRICULUM OF MEDICAL SCHOOLS<sup>1</sup>

IRVIN ABELL M.D. F.A.C.S. LOUISVILLE, KENTUCKY  
 Professor of Clinical Surgery University of Louisville

THE science of medicine and surgery has shown far greater progress during the past third of a century than at any similar period in its history. To those of us who have been fortunate enough to have observed at first hand the developments and attainments of the last 30 years there has been unfolded a panorama of scientific accomplishment replete with absorbing interest and stimulation for the student and pregnant with vast possibilities in the recognition, alleviation, and cure of human ailments.

Until the beginning of the present century, surgery consisted largely in the application of mechanical principles to the solution of pathological problems without the knowledge and safeguards which have since been evolved. While the acquisition of surgical knowledge followed chiefly along empirical lines. Today the advance is chiefly along biochemical and biophysical routes as regards both diagnosis and treatment, physiological research affording the basis upon which such study is made. The intensive tilling of the surgical field has resulted in the growth of many surgical specialties. Intensive study by the various specialty groups concentrated upon organs and systems of organs has thrown a flood of scientific light upon many problems whose explanation had remained heretofore elusive. The recent World War presented many questions which pressed for solution, furnishing the impetus and material for study which eventually resulted in the elaboration of already established specialties and in the development of new ones as well. As illustrative examples, neurologic surgery, thoracic surgery, orthopedic surgery, and oroplastic surgery have been fostered and developed enormously within the last decade under auspices furnished by the recent war.

To attempt to enumerate the advance made by these particular groups would necessitate a rewriting of the surgery of the ailments covered in their domain. While always included in the course of general surgery in the curricula of medical schools, as a result of their present day development and importance they have attained the dignity of departments or sub departments in the surgical section.

Today the operation of the armies of industry, with their unprecedented development and ever increasing expansion, presents medical and surgi-

cal problems, which, while many of them are commonly found in the field of general surgery, frequently show characteristics peculiar to the industry in which they occur. In industrial centers the demand for the solution of these problems has resulted in the development of still another surgical specialty, and such specialists are concerned with the correlation of the various phases of industrial activities with day medical thought and care and as well with the prevention of accidents and the proper care and treatment of victims of accident. The economic aspect of the entire problem is seen at a glance upon referring to the report of the National Safety Council, from which some of the following are excerpts:

Non fatal injuries in industry every year—3,250,000. Deaths yearly caused by industrial accidents—24,000. Deaths during 1928 caused by automobiles—27,500. While no nation wide data on non fatal motor vehicle injuries are available, representative states have reported about 35 non fatal injuries of some seriousness for each fatality. On the basis of this conservative figure there were approximately 950,000 such injuries in 1928. Total fatalities from accidents in the United States during 1928—96,000, constituting approximately 6 per cent of all deaths. The death rate in males from accident is 112.3 per 100,000, being exceeded only by that of heart disease, which claims 187.2 per 100,000. Employees of industry incurring partial disability every year—115,000. Employees of industry incurring total permanent disability every year—1,150.

Estimated annual cost of industrial accidents—\$1,000,000,000. Of the industrial accidents approximately 250,000 are infected cases, the infection entailing an extra annual compensation cost of \$104,227,500 with approximately 450,000 weeks of disability.

The average increased cost of infected over non infected cases is 416 or per cent and the average increase in the disability period is 17 1/4 weeks.

Many agencies, as evidenced by today's program, are uniting their efforts to the end that the injured receive appropriate care and compensation. The American College of Surgeons is actively taking part through its sectional meetings at which some phases of traumatic surgery are discussed, through its program of hospital standardization in which special attention is

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 24-28, 1929.

Hospital connections are imperative. All active members of the group should be on a hospital staff and active in their various departments, as well as active in the movement to better hospitals.

A word of warning should be offered. While a group of this character is essentially a professional organization it has an intimate contact with the world of business and commerce, a contact that must never be allowed to influence its ethical motives. It must never permit itself to become commercialized. No matter what its position in the business world might be a professional group of this nature is essentially medical and it must conduct itself as ethical physicians are expected to behave. The first consideration must always be the welfare of the patient. There must be no solicitation of business connections, nor will that be necessary, for satisfactory service will cause a sufficiently rapid expansion. And in all other respects the group must conform with the code of ethics.

It does not occur to me that finance and fees can appropriately be discussed in this connection. The financial arrangements must be worked out by each group individually and if the group conforms with the code of ethics, the question of fees is already answered.

In conclusion, group medical service for small industries is essentially group practice adapted to the needs of industry. It is group medicine and industrial medicine combined. Large factories provide their own service so the group automatically finds itself serving small establishments. Its purpose is to safeguard the health and life of the industrial worker, and it does so through the following functions:

#### I PLANT SERVICE

- 1 Visits to plant dispensaries or first aid rooms
- 2 Sanitary inspections
- 3 Health instruction
- 4 Physical examinations, etc.

This plant service is entirely within the plants. If a factory is too small to justify a dispensary and individual attention the service is rendered in the group clinic.

#### II CLINIC SERVICE

- 1 Treatment of injuries and occupational diseases occurring in small plants which have no dispensaries
- 2 Special examinations for the purpose of rendering opinions as to diagnosis, cause, and disability of cases in dispute
- 3 Treatment of private patients (A group may practice general and special medicine as it desires.)

#### III HOSPITAL SERVICE

- 1 Surgical and orthopedic care of serious injuries, including reconstructive therapeutics
- 2 Medical treatment of serious occupational diseases
- 3 Care of private patients
- 4 Hospital betterment (All of the active staff should occupy positions in one or more general hospitals, and assist in their betterment.)

#### IV CONSULTATION SERVICE

- 1 Surveys of plants to determine their medical and allied requirements
  - 2 Recommendations submitted in detail
  - 3 Assistance in organizing plant medical departments
  - 4 Supervision of plant medical department
- The organization may consist of the following:
- 1 The directing committee, or director. This committee or individual is responsible for the management of the affairs of the group.
  - 2 The active staff. This may be composed of (1) a plant physician, (2) a general surgeon, (3) an orthopedic surgeon, and (4) an internist who may be also the industrial hygienist.
  - 3 The auxiliary staff. This is composed of (1) professional assistants in clinic hospitals and plants and (2) plant nurses, attendants and clerks.
  - 4 Allied specialists. This comprises the following specialists whose services are supplied on request: (1) oculist, (2) roentgenologist, (3) dermatologist, (4) dentist and (5) laboratory man, etc.
  - 5 Clinic staff. This includes the assistants that are necessary for the service in the central clinic and carrying on the affairs of the group.

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now being given to the equipment of hospitals with material for the most approved treatment of the injured, through its department of Clinical Research in collecting and analyzing all available data concerned with the best methods of treatment in traumatic surgery and through its Board on Traumatic Surgery, which, by means of surveys has acquired accurate data and knowledge upon which to formulate and direct intelligent study. It is apparent that the problems encountered by all of the agencies concerned are in large measure educational, thus being particularly true of the medical profession in furnishing competent men for traumatic surgery. Real progress in the care of the injured can come only when the latter is administered by medical men who understand and are interested in the scientific principles underlying it.

Medical education has seen many changes in the last 30 years conforming to the rapid expansion of medical knowledge while medical and surgical practice has been scientifically adopted to meet changing conditions and indications. The present status and number of industrial and other accidents, the tremendous human and economic loss and wastage they entail and the knowledge that there is decided room for improvement in their care and treatment justify and demand that the teaching of traumatic surgery receive adequate attention. The medical school curriculum is at present already filled to overflowing the tendency to eliminate duplication, to reduce the number of hours of didactic teaching of facts readily accessible in textbook form and to give more time to bedside instruction gives promise of better balanced training with consequent better preparation for meeting the actual contingencies of practice. The principles of surgery must of necessity be acquired by the student as a basis upon which the superstructure of clinical study is to be added. It would seem practicable for the department of surgery so to correlate the teaching of the surgery of trauma that its particular needs may be emphasized without the undue addition of further hours to the curriculum.

Hæmorrhage and shock, burns sepsis assepsis and antiseptics, chest and abdominal injuries can be covered by general surgery. Brain spinal cord, and nerve injuries by neurologic surgery, fractures, reconstruction and rehabilitation and physiotherapy by orthopedic surgery without adding to the number of hours assigned them. The elucidation of underlying principles the demonstration of newer and time saving treatments, the application of procedures destined to

accelerate restoration of function can be properly stressed in a way to sustain instructively the interest of the student in the surgery of trauma. The hospital emergency wards and the outpatient department, especially if the clinical department of the school has an accident service can be made most interesting and instructive, preferably by a teacher who is engaged in some phase of industrial work. Such a teacher can also discuss the medicolegal aspects, compensation law and insurance features pertaining to such cases since an understanding of these combined with a correct ethical equipment, is essential to one who practices traumatic surgery. To impart this information to him while yet a student forestalls any but wilful deviations from professional standards when he subsequently enters a legal and business atmosphere where medical bills, schedule losses, and compensation awards are discussed constantly. The fifth or hospital year is now required by many schools and the majority of the graduates of those not requiring it take advantage of internships when available. If a list of hospitals which maintain desirable and well organized emergency services were brought to the attention of the graduates it would permit such students as are interested in the surgery of trauma to apply for internship therein.

At the present time a few schools are giving special instruction of limited extent under the heading of traumatic surgery, being as a rule conducted by some member of the general surgical or orthopedic staff interested in such work. One graduate school offers a short course under the same heading. With a wider appreciation of the importance and possibilities of traumatic surgery increasing facilities for both undergraduate and graduate training are being provided. Surveys from time to time in the field of practice indicate the needs to be met by changes alterations or additions to the medical school curricula. Two years ago the result of a survey of a relatively large group of physicians was presented to the Association of American Medical Colleges showing their practice to be divided approximately as follows: 50 per cent office patients, 35 per cent home patients and 15 per cent hospital patients, indicating the character of instruction to be imparted properly to equip the graduate in medicine to fulfill the wants of the community he is to serve. In a paper read before the American College of Surgeons last year in the symposium on traumatic surgery Dr Irving Cutter gave the results of an inquiry directed to 1000 graduates of Illinois medical schools excluding those engaged strictly in the practice of medicine or a

medical specialty, showing that from 4 per cent to 20 per cent of their practice fell within the category of surgery of trauma. The report of the Committee on Fractures and as well a study of the litigation centering around and upon the results of the treatment of fractures afford convincing proof of the need for a more thorough teaching of their management and care if greater efficiency is to be attained. The report of the Board on Traumatic Surgery reveals the magnitude of the problem in its various ramifications, from which emerges quite clearly the indication for more efficient undergraduate and graduate

courses in the surgery of trauma, the importance of which justifies the demand that it be fully met. The method by which this indication will be covered must needs be worked out by the surgical departments of the medical schools in those in which the various phases of traumatic surgery are covered in more than one department, a close correlation of these courses with the definite purpose of giving efficient instruction should be sought. In others, where possible all phases of traumatic surgery should be grouped in one course, furnishing the ideal means of giving the subject the emphasis its importance justifies.

## SOME RECORDS CONCERNING TRAUMATISM AND MALARIA IN CENTRAL AMERICA<sup>1</sup>

H. C. CLARK, M.D., PANAMA  
Director, Gorgas Memorial Laboratory

VISITORS to the Isthmus of Panama during the construction period of the Panama Canal frequently sought information concerning the leading causes of death and most of them were greatly surprised to learn that yellow fever, plague, and beriberi, were not among the leading causes of illness and death. It was less difficult to control these diseases than others, but the tragic part they played in the tropics before this period is still uppermost in the minds of many visitors.

I have arranged, in Table I, the various diseases commonly inquired about by visitors. These represent the causes of death determined at autopsy at Ancon Canal Zone from 1904 to 1919.

TABLE I—CAUSES OF DEATH REVEALED BY AUTOPSY

Year	N	A	Y	F	B	A	T	I	D	C	P	S	P	S	B	C	F
1904	6																
1905	269	12	7	7	2												
1906	509	1	5	4													
1907	490																
1908	361					2	3										
1909	295																
1910	45	1															
1911	5	5				1	1										
1912	425	1															
1913	460					2	3										
1914	375					1	4										
1915	188	3	1														
1916	323																
1917	33					7											
1918	253						2										
1919	34																
Totals	5713	23	26	10	15	19	3	1									

N A N, number of autopsies; Y F yellow fever; B beriberi; A ankylostoma; T tetanus; I D C, 1 death in diseases of children; P plague; S P smallpox; S B snake bite; C cholera; F filariasis.

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Ch. 20, October 24, 1919.

For comparison with this record I have arranged Table II to show the leading causes of death in the order of their incidence.

Autopsies were performed on 70 to 90 per cent of the bodies that passed through the Board of Health Laboratory each month so that I believe these autopsy records furnish a fair index of the relative incidence of the causes of death in the Canal Zone. It is thus shown that the chief causes of death were due to pneumonia and tuberculosis. Malaria is the only disease, commonly listed as a tropical disease, that ranks

TABLE II—CAUSES OF DEATH REVEALED BY AUTOPSY

Year	N	A	P	T	Tra	M	& H	I	N
1904	6		1	1					
1905	269		60	9	3	27			8
1906	509		191	22	24	59			23
1907	496		156	35	40	27			27
1908	361		59	63	26	46			25
1909	295		55	31	32	26			31
1910	451		50	91	39	52			37
1911	505		83	102	38	41			36
1912	425		53	79	37	23			27
1913	460		47	89	34	2			26
1914	375		36	78	38	6			1
1915	38		28	56	0	14			12
1916	323		25	81	17	9			0
1917	330		24	51	21	5			23
1918	253		38	68	6	6			12
1919	324		22	53	13	3			14
Totals	5713		928	917	391	352			333

N A N, number autopsies; P pneum. pneumonia; T, tuberculosis; Tra, trauma; M, malaria; & H, hemorrhage; I, influenza; N, nephritis.

TABLE III—FIELD SURVEYS FOR MALARIA

Region	1928	1927	1926
Tela (Honduras)	18.6	24.3	23.9
Truxillo (Honduras)	35.0	33.5	21.0
Chiriqui (Panama)	35.6	26.7	
Costa Rica	19.0	34.9	9.5
Columbia	15.2	21.3	21.0
Guatemala	27.6		40.1
Almirante (Panama)	22.9	21.9	27.1
Preston (Cuba)		24.2	34.8
Banes (Cuba)		24.3	35.9

TABLE IV—HEMOGLOBIN ESTIMATIONS

ON 5,501 PEOPLE

Individuals with hemoglobin index of	Per cent
30 per cent	0.23
40 per cent	0.67
50 per cent	2.9
60 per cent	18.3
70 per cent	47.3
80 per cent	20.1
90 per cent	7.4
100 per cent	0.09

among the first five causes of death in this series of cases, yet the combined forms of external violence exceeded the death rate of malaria. It is not surprising that the construction period of the Panama Canal should reveal many deaths due to violence. The fall in the number of deaths due to traumatism has not been as great during the period of operation and maintenance as one might think because the automobile, the airplane, and shop machinery are taking their toll.

Mortality rates do not necessarily reflect the incidence of diseases of the greatest economic importance as can be shown in the case of malaria.

It has been my duty in recent years to conduct rather extensive surveys for malaria in the labor camps of a large agricultural organization operating along the mainland and in certain islands of the Caribbean Sea. These surveys were made on all the men, women, and children found in the labor camps at the time of my visit. A microscopic examination of a blood film from each individual was done. The method used was the thick drop-film stained and laked in an aqueous solution of Gimsa's stain. Table III shows the results of these surveys.

The island of Haiti shows about the same rate as the mainland, while Jamaica, in its worst foci, usually showed a rate of about 15 per cent. These races of high tolerance for the disease seldom seek treatment in a dispensary or hospital yet the 'labor efficiency' is lowered to an important degree. Table IV shows the hemoglobin estimations conducted (Tallquist scale employed).

This shows that a large proportion of the laborers scale from 60 to 70 per cent in their hemoglobin estimations. Their ability to do manual labor in a consecutive daily manner is pretty well reflected by these same figures. Malaria, malnutrition and intestinal parasites all participate in producing these results, but in my opinion malaria outranks the other factors.

It is difficult to impress even on the local medical profession, how much malaria remains untreated in the field and how many individuals there are who can carry the infection with little or no acute symptoms. In order to get some figures on this subject, I checked the field surveys in three large coastal plain areas against the hospital cases under treatment on the days I collected blood films from the field. There were 126 labor camps in these three areas which had under treatment for malaria in the hospitals just 26 cases. My survey covered only 24 of these labor camps. There were 555 individuals found positive for the parasites of malaria in these 24 camps and 137 of them were as heavily parasitized as the 26 hospital cases on the day of their admission for treatment. The individual resistance is great in these races with a high tolerance to the disease, but malaria takes its toll to some extent in each infected individual. The course of traumatic surgery and obstetrics is frequently modified by an associated attack of malaria. The doctor must constantly keep in mind this disease as well as postoperative infection since many of our post-operative temperature rises are due to malaria. In spite of the tragic part played in our past history by epidemics of yellow fever and plague, I feel sure that malaria has been and is at present the great economic problem of the tropical coastal plains. The successful development of permanent industries in the coastal plains of our tropics must be paralleled with constant effort in the control of malaria.

## REFERENCES

1. CLARK, H. C. A chart representing the incidence of the more common causes of death on the Panama Canal as found at autopsy during the years 1904 to 1919 inclusive. M. R. 61506. Panama Canal Press 1920.
2. Idem. Ann. Rep. M. Dept. United Fruit Company 1928 p. 103, 246, 72.

INSPIRATION AND IDEALS OF THE BOARD ON TRAUMATIC SURGERY<sup>1</sup>

FRANKLIN H. MARTIN, M.D. CHICAGO  
Director General American College of Surgeons

I WAS very proud of the meeting this morning, beginning with the reading of the Minimum Standard for Traumatic Surgery. The address of Dr. Slobe showed him to be an administrator as well as a surgeon. Dr. Schram gave us the fundamentals in his talk. Dr. Wilson, the head of the marvelous medical department of the American Telephone and Telegraph Company, is a practical man in industrial medicine and surgery, as is Dr. Cheney, director of a most efficient medical department in a large industry. Armour and Company. It was interesting to hear the address of Dr. Selby on medical service in small industries, that of Dr. George G. Davis on transportation of the injured, and that of Dr. Herbert Clark, a scientist who has been trained in traumatic surgery with the discussion of his old chief, Dr. Deeks, on the problems of transportation of injured workers on the fruit plantations.

In the discussion by Dr. Abell of traumatic surgery in the curricula of medical schools, I expected to hear more emphasis placed upon the importance of administrative and organizing ability as essential qualifications for successful industrial surgeons. In time medical schools will segregate their classes and determine not only those who have administrative minds but those who have medical and surgical minds in order to qualify them as industrial surgeons.

In 1920 a man with vision started this movement for the better care of the injured. As a railroad surgeon and chairman of the Medical and Surgical Section of the American Railway Association, he addressed that society saying that the best service was not always being given to patients because they were not always sent to proper hospitals. He explained the standardization of hospitals by the American College of Surgeons and the requirements relative to the care of patients. The enthusiastic response of the railway surgeons led to the drafting of a resolution which recommended to the American Railway Association that whenever possible only hospitals rated as Class A by the American College of Surgeons be recognized and when railroads have their own hospitals, that such institutions not already so classified be brought to such standard. A committee of surgeons told the story of hospital standardization presented the resolution and asked that it be adopted whereupon the

American Railway Association, on November 16, 1921, approved the action of its surgeons, and adopted the resolution as presented. This meant that instructions were sent to 14,000 surgeons of whom less than 4,000 were members of the American College of Surgeons. What was the result? It was found that the average days' stay per patient was reduced from 14.6 to 11.9 days, or a saving of 2.7 days. The beginning of this movement is due to the efforts of our old friend Dr. Daniel Z. Dunott, of Baltimore, whose untimely death we so much regret.

After a time when standardization of hospitals became better known and Dr. Dunott became the head of the medical department of one of the big indemnity companies, he came to us one day and said "Why don't you do for industrial surgery what you did for hospitals?" If there is anything to be done that will improve surgery and hospitals and the treatment of cases, we are willing to do it.

Three years ago a Board on Traumatic Surgery was organized. This Board was appointed after 2 years investigation of the subject, and so we are here today to discuss matters pertaining to industrial surgery. Some of the leaders in this specialty have talked to you this morning in an effort to convey the fact that if you are going to do industrial surgery you must have something besides a knowledge of surgery. The head of an industrial surgical and medical organization not only must have the education of a physician but also must have administrative and organizing ability. He must have also a high moral and ethical standing—be able to meet the crook and turn him down.

One reason we are discussing this subject now is that for many years our state credentials committees rejected applicants for Fellowship in the College because such applicants were contract surgeons working on a salary. There might have been good reason for that action at one time and there may be good reason for it now, but at least we investigate the application. If the contract surgeon divides fees with indemnity adjusters or with poorly equipped hospitals or makes other unfavorable financial arrangements, he is the kind that should not be accepted. Since this Board has been organized we have discriminated, the salaried contract surgeon who is on the square,

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 14-18, 1929.



who is a competent surgeon and who is an administrator in a great industrial organization should be accepted for Fellowship in the College.

For three years, industrial and labor organizations and indemnity companies have supported this movement for the better care of the injured. The program is accepted by those who are vitally interested in the man in industry. It is accepted by the profession and by this great organization which is taking *we hope the leadership in this work*.

Advisory committees have been appointed in every state to help us select the type of men who know medicine and surgery and who are in position to administer and organize medical departments. There are many names on our list at the present time. Of the thirty thousand men who practice surgery in the United States a large percentage of them at least 50 per cent will in time help to care for the injured and sick employees of industry.

## SUMMARY OF SURVEYS MADE BY THE BOARD ON TRAUMATIC SURGERY<sup>1</sup>

E. W. WILLIAMSON, M.D. CHICAGO

THE initial report of the Board on Traumatic Surgery to the Board of Regents of the American College of Surgeons was presented in such a form as to leave no doubt that there exists a distinct economic as well as a scientific problem in the care of the injured in which surgeons could be of great assistance in improving conditions in this special field of surgery.

In order to secure direct information relative to prevailing methods for the care of accidents in industry and the results of treatment, surveys have been conducted in large industrial centers of the United States.

To one familiar with the subject, the summaries of these studies may seem elementary, although the reports have a definite purpose. The information contained therein is fundamental and worthy of exposition in order to supply basic material for a constructive program in traumatic surgery.

### ORGANIZATION AND ADMINISTRATION

Special attention has been given to a study of organization and administration of the medical service in industrial plants, insurance company medical departments and hospitals.

There are many large companies in which the medical service is centralized and successfully operated under the supervision of a chief medical officer with full administrative responsibility. This plan of organization is recommended.

In contrast to this plan there are many industries which disregard the importance of medical supervision by placing the medical service subservient to and under the direction of another department of the company directed by non medical officials.

This plan is fundamentally unsound and should be condemned as it delays the development of a complete medical service.

Large industries often assign the administration of the compensation and medical department to the claim division. The legal aspect predominates and the accident case is regarded essentially as a claim imposed by compensation law, while the medical service extends no farther than the employment of a physician to treat the injury.

We emphasize the importance of the closest cooperation between the medical claim personnel, safety, and employment departments but are unable to justify the administration of the medical service by a department in which the decision of medical questions and the appointment of surgeons are entrusted entirely to the judgment of non medical officials.

Plants which do not have medical departments are practically without medical supervision. They depend upon the use of a first aid service and a neighborhood physician to treat accidents. The insurance company is often entirely relied upon to provide treatment and arrange settlement of cases. Organization and scope of service are thereby reduced to the simplest terms—sufficient only to meet the requirements of the law. The result of minimum equipment and service is maximum absenteeism due to illness and injury.

In the selection of a physician professional qualifications are not always regarded as an important major requirement. Too often the physician is selected on the basis of (1) location in the vicinity of the industry, (2) agreement on fees for professional service, (3) personal acquaintance or relationship between the physician and the com-

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 14-15, 1929.

pany official, (4) recommendation of the insurance company carrying the risk, and (5) local reputation as an industrial surgeon.

Physicians are employed full time only in large industries which maintain an extensive medical and surgical service. The most common arrangement is the employment of a physician on call, to whose office most accident cases are sent for treatment. These physicians seldom have an official connection with the industry and in no way are allowed the responsibility for directing the accident and health activities of the plant. In reality the doctor is often engaged on a temporary status and may be relieved of his position with the company at any time particularly so if he is employed on a fee basis or if there is a change in indemnity carriers. Thus, under these conditions the relationship between the physician and the industry is not close enough for the most efficient service.

The responsibility for the health and accident service of an industry should be fixed upon the physician who may then be held responsible for end results.

To raise the standard of industrial medicine and surgery there must be an improvement in the environment of the physician, particularly the physician who maintains an office in the district, in order that the field may be amply supplied with well qualified practitioners. This means (1) a solution of the economic problems with which he now contends, (2) the administration of medical matters by medically trained persons (3) a closer working relationship between physician and industry.

#### ADJUNCT MEDICAL SERVICES IN INDUSTRY

Adjunct medical services in industry are supplied by hospitals, medical departments of insurance companies and private offices of physicians which admit a vast number of industrial accident cases for treatment.

Instead of Industrial Hospitals designed equipped, and organized especially to serve groups of plants in the same localities practically all the general hospitals admit industrial accident cases for treatment. This wide distribution rather than centralization of cases accounts for the wide diversity in standards of service and variation in charges made therefor.

Some hospitals which operate active departments in traumatic surgery are well equipped and provide adequate service. Many others are in need of better facilities and organization in order that they may do their part in returning the great toll of injured to industry in the shortest possible time and with the least amount of permanent disability.

Because of the important position occupied by hospitals in the treatment of the more severe injuries, and on account of the wide variation in service there is an urgent need for raising the standards of these departments. Special attention should be directed to organization, personnel, equipment, and diagnostic, and therapeutic facilities. The approval of a complete unit of service clearly defined would serve as a guarantee to industry that the department is giving the best treatment that modern medicine affords.

Indemnity companies have become active agencies in providing medical service to industry by the establishment of their own medical departments. There is a trend toward an increase in the number of insurance clinics and in the number of patients treated therein.

The indemnity companies' reasons for operating medical departments are

- 1 *Economy* Installation of a centralized medical department is said to lower medical expense and compensation by reducing temporary total disability thus allowing the employee to return to work with a minimal loss of time.

- 2 *Better control of cases* Patients may be concentrated to a large extent in the insurance medical department under the immediate direction of the company's physician who is familiar with compensation practice and in a position to reduce the number of contested cases and delayed settlements.

- 3 *Settlement of claims* The settlement of claims is made more readily through frequent contacts with the claimant in the insurance medical department.

- 4 *Business assets* The medical department is an excellent business asset as it invariably creates a favorable impression upon the prospective buyer of insurance and upon the policy holder.

Physicians in industry are engaged principally in the treatment of injured employees. Even today numerous industries have not extended the work of the physician beyond the requirements of the Compensation Law. The delayed development of a complete health and accident service is due largely to the failure of the medical profession to acquire active leadership in the promotion of this important specialty. Physicians have failed to determine a complete unit of service and have accepted by the employer as an essential part of his business.

#### CONCLUSION

That there is yet much to be done is shown by the fact that illness causes from five to twenty five times more loss of time than accidents and that only a comparatively few plants to date have gone

further than to care for accidents. Reliable authorities<sup>1</sup> state that "industrial hazards cut ten per cent from the span of life and that the remedy is neither impractical nor out of reach." The remedy is the employment of specially trained medical service that would provide health education, correction of physical defects, proper placement of

<sup>1</sup>Louis I. Dublin *Me ropes* and L. E. Insurance Company

employees in jobs agreeable to their physical capacities, a more rigid control of the predisposing factors of occupational diseases and the periodical examination of employees.

Let us carry on an active program not only for raising the standard for the care of the injured but also for giving special attention to a health inventurum in industry as well as in hospitals.

## VALUE OF MEDICAL DEPARTMENT TO INDUSTRY AND ITS NEEDS<sup>1</sup>

R. V. MASSEY, PHILADELPHIA

Vice President, Pennsylvania Railroad Company

It is not only a pleasure to appear before this organization, but an honor which anyone might well appreciate. The Pennsylvania Railroad has been engaged in promoting the health and well being of its employees for a long time. The same is true of other large American railroad systems.

Much of our work has been humanitarian in character, intended to foster the sense of loyalty and increase the attractiveness of the occupation by providing safeguards against misfortune.

The first important agency for carrying on work of this kind was the establishment of our Voluntary Relief Department in 1886. The primary purpose of the relief department is to provide a means whereby our employees can by payment of small sums monthly secure for themselves and their families cash benefits payable in the event of death, sickness or accident. The railroad bears the entire cost of operating the department so that the contributions made by the employees are available, without any deductions whatever, for the sole purpose of paying benefits and allowances. The protection afforded our employees in this way was made available at a time when no other insurance agencies were in existence to provide it at reasonable rates.

At the end of 1928 the relief department showed a membership of nearly 185,000 and it had distributed over \$4,800,000 in benefits during the year. Since its establishment in 1886 over \$101,000,000 has been paid in benefits and allowances while the railroad has contributed over \$18,000,000 toward carrying on the work of the department.

These provisions for sick and injured employees and designated beneficiaries in the event of their death are actuated by truly humane and benev-

olent purposes, and in their continuous development are bringing about a feeling of mutual regard and respect between capital and labor.

A feature of our relief department work and one which has assumed great importance is the medical and surgical staff maintained for the benefit of our employees.

This department has under its supervision and scattered through all parts of the railroad system 118 physicians and surgeons who devote their entire time to employees requiring treatment. These men constantly strive to keep the minds and bodies of our employees in the best possible condition. We seek, through rigid physical and mental examinations, to prevent men liable to sudden incapacities from entering our service and thus to avert possible trouble, to keep an accurate check, through periodical examinations of the men actively engaged in the operation of trains and to see, by requiring compliance with proper standards that the eyes and ears of railroad men are always on the alert.

Our full time physicians are stationed at important centers along the railroad and connected with each office is a dispensary where employees may secure free treatment for both accident and sickness. Emergency supplies are available for immediate use at strategic points and fully equipped first aid cabinets have been placed in many locations. At other points, such as yards, shops, and transfers a complete first aid room is in operation.

First aid boxes are carried in baggage cars and cabin cars and are available at other points where any number of men are employed. Employees in train service, in shops in yards, and in our maintenance of way department including foremen, receive first aid instructions to enable them

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, Oct. 14-18, 1929.

to act promptly and properly in cases of emergency

These demonstrations are of a practical nature, the employees being trained to apply splints, place a person on a stretcher, apply bandages, stop hemorrhage and treat shock. They also are trained in the art of aiding respiration by artificial methods. These instructions are given by the physicians of our medical department.

Uncompromising cleanliness in Pennsylvania dining cars is obtained through inspections by our physicians of all food and kitchens, and in addition all dining car employees are subjected to a thorough physical examination each month.

In addition to our regular medical force, we retain the services of a staff of outstanding specialists in practically every disease and every branch of surgery. We also retain eye specialists to whom any employee is free to go for examination, treatment, surgical work, or prescription for glasses.

Another important work in connection with the operation of the relief department is the rehabilitation service. Every report of disability occurring among our employees is carefully checked up and, if necessary, the patient is placed in the charge of a specialist for his opinion and if deemed advisable for treatment.

What we try to do, in every case in which there is any way to effect it, is to cure the man as soon as possible and get him back to his old position and full earning power. If it is not possible to return him to his former occupation, it is the function of the rehabilitation bureau to find a suitable position for the man, so that he can again be self supporting.

The World War drew the attention of all to the necessity of reclaiming disabled veterans for suitable occupations upon return to civilian life. Figures compiled at that time indicated that casualties were greater in industry than in war. It was not until after the war period that any particular attention was directed toward the solution of this important problem.

We believe that the Pennsylvania Railroad was a pioneer in this great humanitarian work, and the service rendered by this branch of our service in placing our disabled workers in gainful

occupations has done much toward relieving distressing conditions.

In addition to the physicians under the supervision of the relief department, there are approximately 700 company surgeons, stationed in all important towns on the railroad system. These physicians give attention to accident cases when called upon in an emergency.

This complete medical and surgical force, which necessarily involves a large expenditure, clearly indicates our desire to render efficient medical service to our employees.

It is quite evident to our management that the physician has found a permanent place in our business life. Communities are more and more coming to realize the value of improved sanitary standards and health conditions and are spending large amounts to secure them. Our physicians can and do carry these ideas into the minds of our employees, who themselves frequently form a large part of the population of the towns located along our lines, so that our workers willingly assist in the maintenance of sanitary homes, streets, and public places, and in the safeguarding against the inevitable hazards.

We believe that the medical work which we are maintaining in our industry has demonstrated its economic value, the full extent of which cannot of course, be measured merely by dollars and cents. We feel that our medical department is rendering an essential service in helping to build up a high physical standard among our workers.

As business grows more complex and intense, the physician in industry will necessarily become a more valuable assistant in the management of our railroad.

Our railroads have, especially since federal control, made marked advances in service to the public, and these results in a large measure have been accomplished by a realization on the part of the railroads that one of the most important factors in the conduct of business is the human relationship. We, therefore, feel that the result which has been obtained is due largely to the care that has been given our employees, when disabled through sickness or accident, by the men in the medical service of the railroad who are members of your great profession.

VALUE OF MEDICAL DEPARTMENT TO INDUSTRY AND ITS NEEDS<sup>1</sup>

P. A. RICKCORD NEW YORK

Director of Personnel and Statistics Brooklyn Edison Company

IT is thought in connection with this paper on industrial medical work that the best results will develop if the statements contained in it are largely confined to, and based on definite practical experiences. For this reason the following statements are based on the work of the Brooklyn Edison Company's medical bureau which is now in its eighth year of operation and they are intended to suggest the value of these activities to industry.

The medical activities of this company may be divided into three groups namely the examination of new employees, the maintenance of the health of existing employees and the care of accident cases.

With regard to the first mentioned activity the examination of applicants this might now be said to be an almost absolute necessity to industrial concerns. In the first place it seems to be an exceedingly unwise procedure to allow an employee to do work for which he is physically unfitted.

It is of course the medical bureau's responsibility to make the decision as to whether the employee is suitable for a particular vacancy or not. In modern organizations the physician is or should be provided with an analysis of the various positions. This job analysis defines the work and the conditions under which it is performed and provides the basis on which the physician may make this judgment.

One of the important uses of the physical examination of applicants is the opportunity it gives for adjusting them to the right work. Most concerns can and do employ individuals with minor defects but they keep in close touch with them to see that the condition is not exaggerated. The procedure that no concern can afford to adopt is the wholesale employment of decidedly defective individuals. This undesirable condition is prevented by the physical examination of applicants.

Large industries disburse much money in the way of sick pay, insurance and death benefits. In the Brooklyn Edison Company these payments amount to approximately a quarter of a million dollars annually. If permitted they might easily reach twice that amount but instead they are limited through the physical examinations given to applicants for employment.

Looking at the question of medical examinations from another standpoint, the company is

entitled to full value for the money it pays in wages. This cannot be accomplished if the employee is physically defective at the time he enters the organization.

The present speaker recently witnessed the examination of a group of laborers. About 50 per cent were rejected for causes which would seriously impair their activity on the job, and which would perhaps be a fruitful source of accidents. The rejected applicants could not possibly have produced more than one half the quantity of work which might be expected from the others.

As regards the second group of activities namely the maintenance of the health of the employee perhaps the largest part of the physician's time under this head is given to voluntary requests on the part of the employees for advice and minor treatments. These treatments are almost entirely of a type that the employee would neglect if it were not made convenient for him to receive them.

The advantage to the company of these treatments is that in numerous minor conditions, for which ordinarily time off would be taken, employees are enabled to remain at work and to continue to devote their time to the job almost without interruption. Those employees who would ordinarily slow down and become inefficient, because of a temporarily painful condition, are often relieved by treatment and quickly return to their usual effectiveness.

In an efficient organization the supervisory employees work very closely with the medical bureau and are usually very glad to refer to it all questions concerning the physical condition of employees. It is the medical bureau which should decide whether the employee shall remain on the job or go home. No other group of individuals in the company can properly make a decision of this nature.

Increasing evidence indicates that where these opportunities for medical advice exist, the employee takes a great deal more treatment than would otherwise be the case both in the company's medical bureau and also at the hands of the family physician. This is of course the objective of most companies to keep the employee in the best of health. The organization is usually willing to permit its own physicians to do preliminary work along this line but also feels that much

<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 12-13, 1929.

of it must be provided by the employee's own family physician.

If the medical bureau succeeds in stimulating the employee to look after his health, it has accomplished its main purpose. Thousands of patients a year present themselves in a medical bureau like that of the Brooklyn Edison Company in which the physicians insist that the employee take treatment from his family physician, treatment which would otherwise be neglected by the employee.

Another important factor in maintaining the employee's health is the supervision on the part of the physicians of the nurses' visits to sick employees and the examination of these employees on return from sickness. In connection with this work, the company's best interests are represented by the exercise of a fine discriminating judgment on the part of the physicians.

Employees must not be permitted to sham illness, nor to extend absences after a cure has been effected. Also employees returning after an illness should not be permitted to commence work if, in the opinion of the physician, a further absence seems to be necessary. The supervision of these conditions by a physician, and the exercise of justice and firmness by him in dealing with them, is of much importance to the company. Unless this kind of judgment is exercised the sick payroll is likely to increase enormously.

In connection with the treatment of sick employees by the family physician the company's medical bureau can be of great assistance. Since it is in contact with the employee all the time it usually has an excellent medical history it can place at the physician's disposal. In addition it can furnish X-rays, biological analysis and reports of various kinds which from time to time it may have been instrumental in securing.

Since it pays the employee during sickness it can bring to bear the moral support on the employee in the matter of treatment which the family physician and the company's physicians deem wise in the case. In general where these facilities exist very close co-operation results, to the great advantage of all the individuals concerned. In practice the employee very much appreciates the service he has received and the activities become a means of enhancing his good will toward his company.

If the employee is satisfied he will ask the company's physicians about procedures for his family, what hospital to use, what physicians can do a particular piece of work where he can buy certain surgical apparatus. It might be interesting to note that in the medical bureau of the Brooklyn

Edison Company, where it is thought that fine relationships have been established, the total number of medical contacts between the physicians and employees have reached a total of seventy-five thousand a year, the number of employees being approximately ten thousand.

The third main group of activities consists of accident treatments and related work. In many concerns accident cases absorb much money, by the absence of employees and disability compensation. Therefore, any improvement that can be introduced both in the way of prevention and in the treatment of accidents is of great benefit to industry.

It is a good start to insist that every accident of every kind, no matter how small, be reported to the medical bureau. Also it is not too much to ask that every employee so reported receive treatment from the physicians of the company. Only by such rules can the supervising physicians be held responsible for preventing the development of serious conditions.

If there were any question as to the value of systematic industrial medical activities the work conducted in connection with accidents alone would remove such a question. When an accident occurs it is a great reassurance to feel that the condition of the employee was known before the accident took place and that only as much compensation can be claimed by him as is justified by his injury.

Experience has shown that sometimes a medical bureau will pay its expenses by what it can save a concern in its accident activities alone. Until recently it was almost a rule for an injured employee partially to lose the function of an injured part. In a concern which has an effective medical bureau with facilities for giving massage and similar treatments, loss of function has practically disappeared, and with its disappearance many thousands of dollars a year have been saved.

Accident cases frequently involve the attendance of a physician at court. Attendance at court is an expensive undertaking, both for the physician in regular practice and for the company which employs him occasionally for this work. Besides as a rule he will not have had personal contact with the accident involved or the employee concerned.

It is very advantageous to have a physician regularly employed who can do this work. If medical work is properly organized, with sufficiently skilled medical talent, the company's physicians can usually arrange their time and their services so that court work can be readily undertaken. In the Brooklyn Edison Company, we

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<sup>1</sup>Presented before the Conference on Traumatic Surgery, Clinic, Congress of the American College of Surgeons, Chicago, October 14-18, 1929.

WHAT BUSINESS EXPECTS OF THE MEDICAL PROFESSION<sup>1</sup>

JAMES S. KEMPER, CHICAGO  
President Lumbermen's Mutual Casualty Company

IN an article which recently appeared in the *New York State Journal of Medicine*, Dr. Winslow, of New Haven, called attention to a famous Chinese proverb, which goes something as follows: "The high grade doctor serves the nation, the middle grade doctor serves the individual and the low grade doctor merely treats physical ailments. The doctor who not only considers his patient as a whole individual rather than a mere mass of symptoms but also considers the entire life of the individual in relation to his occupation and his home and the society in which he lives, is indeed the one who serves the nation and who serves mankind." In the reference I shall make to the medical profession I shall have in mind and I hope you will have in mind, that the great majority of its members classify under the Chinese proverb as high grade doctors.

Except as applied to life insurance the interest of insurance companies in co-operative work with the medical profession came with the enactment of workmen's compensation legislation in the year 1911 and the years immediately succeeding. True, the casualty companies had medical departments in connection with their health and accident business but by and large these departments were maintained not so much for the benefit of the injured person as for the protection of the companies against possible fraudulent claims. I regret to say, too, that in some cases medical departments were used more largely to defeat claims than to justify them.

During the early days of compensation legislation there was a disposition on the part of some insurance companies to view the payment of compensation claims in much the same manner as they had previously viewed the payment of indemnities under health and accident contracts and employers liability policies. With the advent of compensation, however, came a largely increased interest on the part of the employer in the handling of payments to his injured men. That combined with the forward looking, humanitarian viewpoint of many of the insurance companies, brought about in a comparatively few years a complete revolution in the insurance attitude toward the whole question of the care and compensation of injured men.

I well recall that in the early days of our own company, we were taken to task by an insurance

executive of the old school who, in all sincerity, predicted for us a disastrous future if we continued our policy of immediate recognition of injuries to workmen and proper compensation to, and rehabilitation of, injured men as a just charge against the cost of operation of any business.

I recall, too, that our attitude toward the medical profession also was criticized and I think in good faith. It seemed to us that if the spirit of the compensation act was to be carried out properly it could be done only through the closest possible co-operation and the utmost effort toward mutual understanding between the employer and his insurance carrier, the employee, and the doctor. So we took the doctors into our confidence and gave them practically *carte blanche* all along the line. It was rather unusual for an insurance company to say to a doctor that it would leave its interests entirely in his hands and yet that is exactly what we did and it is with no little pleasure and gratification that I am able to say to you today that our confidence was not misplaced.

Business expects much of the medical profession and properly so. Admittedly there is a great deal that could be criticized in the way of inadequate and unskilled attention, acceptance of so called split fees, professional jealousies, and unnecessary and unjustifiable red tape, particularly in hospital procedure. I cannot refrain from taking this opportunity of mentioning to you one particular rule in vogue in some hospitals which I for one have never had satisfactorily explained. I refer to the rule that makes it impossible for a nurse to communicate directly with the doctor in charge of the case and instead requires that all her communications with the doctor be made through the interne.

I hope and believe that evidences of what may be unnecessary red tape in the medical profession are exceptions that prove the general rule of your sound judgment and common sense.

If the modern business man were to make one recommendation to the modern doctor it would be to take the mystery out of medicine. American business long ago discarded its swaddling clothes in the matter of business policy. Today, it not only collaborates and co-operates with competitors in matters of mutual interest but it encourages employee ownership, customer ownership, and public ownership. And it takes the customer



believe there has been a great improvement in this service since this method has been followed.

The foregoing statements do not take into account the many activities of the physicians which are more or less special to the company which employs them. The matter of resuscitation work is one of these specialties. As a rule the physician in regular practice does not know much about the latest developments in this field.

The physicians of the Brooklyn Edison Company, in co-operation with several of the leading medical colleges, have developed a highly organized technique. Since they cannot be on the spot at every drowning or gas asphyxiation case they have made arrangements whereby all employees practice resuscitation four times a year. In addition the physicians never lose an opportunity to demonstrate this technique when requested to do so before local medical associations, fire and police departments, life guards and similar groups.

If the work of instructing employees is well done it is found that they are only too willing to learn the physician's instructions and to put them into practice. No hours seem to be too long for them or sacrifices too great when called upon for assistance. Recently some employees were called upon to help in a gas asphyxiation case. By taking turns, they worked continuously for thirty hours. In connection with this case the following thoughts were expressed by the director of the Methodist Episcopal Hospital to Mr. M. S. Sloan, president of the Brooklyn Edison Company:

My dear Mr. Sloan:

I wish to express our appreciation of the splendid service rendered by your company in the case of Mrs. Schindler and her two children who were brought into our Hospital by our ambulance unconscious from gas poisoning. We were all much impressed by the efficiency of the organization in their efforts to help these patients.

I would like also to commend the men who were active in this good work. They were very courteous, considerate and diligent. One of them gave his blood for the transfusion which was undertaken in behalf of the little boy. We have a Blood Transfusion Fund here but he would not accept any compensation.

If the medical work of the Brooklyn Edison Company is efficient, it is based on the thought that was expressed by Mr. Sloan to the effect that "we must try to do our work at least a little better than any one else is doing it." And in the effective carrying out of these instructions the services of the supervising physician, Dr. J. J. Wittmer, have contributed most.

It is inspiring to note the grip that the physicians have on the employees' medical welfare and how splendidly informed they are at all times of the physical characteristics of practically all employees.

One is led to suggest that properly organized medical bureaus in industry have an almost unrivalled opportunity to develop and maintain the health and productiveness and therefore happiness of large groups of individuals in a manner which is almost impossible in any other connection.

against sacred human life. The true measure lies in the preservation of invaluable personalities, in the retention of loyal and experienced workmen, and in the satisfaction that comes from defeating death, disfigurement, and disaster.

Business expects to be held to the highest mark of idealism in the care of its injured workmen. By the same token business expects that traumatic surgery will co-operate in eliminating those who would prostitute the profession, who would bear false witness or condone perjury, or who would contribute in any way to an improper reward to an individual, which must always be to the disadvantage of the fair, honest, and honorable.

Yours is a great heritage. Through all the years men and women in every rank of life, in society and in business have entrusted their all to your care. It should be inspiring to you, as it is to the

world at large, that you have measured up to this great trust, to this great responsibility. You men who have interested yourselves in industrial surgery are in a comparatively new field. The record you have made, measured by any standard in your profession or in the business world at large, is worthy of our best traditions.

But the field is large and the skilled laborers, comparatively speaking, are few. I doubt not that in the development of your work you will have the full co-operation of your profession as a whole and I know that I speak for the forward looking and right minded executive officers of the casualty insurance business when I say to you that you will have, too, from them in full measure the consideration, the co-operation, and the conscientious support which you and the cause you serve so fully justify.

## THE VALUE OF MEDICAL SERVICE TO AN INSURANCE COMPANY<sup>1</sup>

F. HIGHLANDS BURNS, BALTIMORE  
President, Maryland Casualty Company

**F**IRST allow me to express my appreciation of the honor done me, and for the opportunity given me in being invited to say a few words to such a distinguished body. Being a layman, I confess to a feeling of embarrassment, but because I am a layman and very much interested in the surgical side of the medical profession, I hope I may be able to present to you a viewpoint which you may not have stressed in your daily activities.

Since the majority of those injured in industry receive the benefits of workmen's compensation legislation and since the casualty companies play such a conspicuous part in making the workmen's compensation laws effective, my interest in the treatment of traumatic cases can be readily understood.

The company of which I have the honor to be president, expended in 1928, \$1,578,302.00 for surgical and hospital fees in the treatment of industrial injuries under workmen's compensation policies alone, and \$130,000.00 more in medical fees under policies other than workmen's compensation. If all the other companies paid in the same proportion they would have paid the substantial sum of \$27,000,000 in 1928 to the medical profession under workmen's compensation policies alone. I cite these facts to indicate to you

that the insurance carriers are fully cognizant of the problems which confront them jointly with you in the big social problem which exists in the form of industrial accidents.

Fortunately, in the whole scheme of workmen's compensation insurance a community of interests exists, which makes it possible and desirable for all factors involved to work in harmony. A claim arises because someone has been hurt. The amount of money paid in settlement of the claim is directly proportionate to the speed and degree of recovery. The employer's production depends upon the integrity of his force. The sooner his injured employees return to work, the better served are his interests. The injured man suffers the loss of a portion of his wages while he is disabled, so the sooner he gets back to work and the more completely he is restored to full wage earning capacity, the less poverty and want exist in his home. Thus the surgical care of the injured assumes a position of prime importance.

Through ignorance or lack of foresight, up to the time workmen's compensation went into effect in this country, the large majority of casualty companies did not take the interest in the question of surgical attention they should have. Under their policies, they were responsible for the

<sup>1</sup> Presented before the Conference on Traumatic Surgery, Clinical Congress of the American College of Surgeons, Chicago, October 24-18, 1929.

and public into its confidence. Open, frank, straightforward, fair dealing has come to be the rule and not the exception in modern business.

And so we of business suggest to you of medicine that you take the customer and the public into your confidence. We commend the steps you have already taken to tear down the walls of secrecy that too long have surrounded your fine profession. We feel certain that if you do succeed in taking the mystery out of medicine it will redound to the credit of the profession and add tremendously to its accomplishments and to your own satisfaction and profit.

Reverting now to the insurance aspect of the situation. If the compensation insurance carrier as representative of the employer is adequately to fulfill its mission, it must have from you the best and most conscientious effort you can give. It is reassuring in this connection to observe the increasingly prominent position the industrial surgeon holds in the profession and the increasing respect in which he is held by insurance. There is scarcely a company of any consequence today but has a medical department made up of the best talent available. And it is encouraging too, to observe that the average staff surgeon is open minded with respect to new developments in the handling of cases and is invariably willing to benefit by the judgment of a fellow surgeon outside.

Insurance companies now view the selection of a medical staff as a matter of first importance. This is not only proper from your standpoint but necessary from ours. It is much more difficult in the smaller communities to get competent surgery for industrial accidents than for such work as appendicitis for example. When you realize that a very large proportion of our losses come from permanent partial disabilities left by fractures you will appreciate how important it is that we should have not only good surgeons but those skilled in traumatic surgery.

Not a day goes by in our company that we do not want the name of someone in Michigan, or Iowa, or Minnesota or some farther away state to do important surgical work. It seems to me that the American College can do the profession and business a distinct service by making available to those of us who represent the employer information as to the men best equipped to do traumatic work. I understand that something is already being done by the profession itself to provide more intensive graduate courses in traumatic surgery. I cannot conceive of a better method to equip this great specialty in surgery as it deserves to be equipped. The path which has led to specializing in industrial surgery has been too haphazard in

the past and if a definite channel could be established similar to that provided for those wishing to specialize in eye, ear, or nose work, it would help both the profession and the industry it serves.

There is one great field of industrial surgery and insurance medical service still in its infancy. I refer to the rehabilitation of injured men, the restoring of victims of industry to a status of self respect, again making them able to support themselves. In my judgment there is scarcely a task facing you, the medical profession, and us in business today which has a better right to demand the best of effort and brains that we can lend. The work being done by federal and state agencies should be supplemented by organized help from private agencies. Every contribution toward making rehabilitation more effective is a great social service and I am sure you will agree with me that the medical profession and business should become increasingly active in this field.

In the history of the world this of all times is the economic era. In this era the world looks to business for the maintenance and enhancement of that standard of living which makes the home life of the artisan of today more expansive and comfortable than that of the king of yesterday. American business has measured up to this opportunity. American standards of living, conveniently measured in the number of automobiles or bath tubs, for example surpass anything heretofore known.

To grasp fully the opportunities of the future business must first of all be kept fit physically. We look to you of the medical profession to do this job for us and to do it even better in the future than you have in the past. We ask you to help us fit the applicant to the work suited to him. The efficiency of men and women in business should be improved by taking adequate care of those whom the workers leave at home in the morning and return to in the evening. We should extend every effort to see to it that the man who is injured is made comfortable and is returned to work without depreciation in his capacity to do work.

We expect in this field that you will indeed go on from wonder to wonder so that the traumatic surgical marvel in repair and rehabilitation of today will be the commonplace of tomorrow. I am sure you would not want us to set for you an attainment any less lofty. Particularly we want you to place an emphasis upon human values that will prevent the possibility, however slight that possibility may be, that dollars and cents will ever even unintentionally or thoughtlessly be allowed for one moment to weigh in the balance.

tion laws. He is as much governed by those laws as the insurance carrier, the injured individual or the employer, and if he is going to participate in the whole scheme he must make himself an integral part of it in spirit and in practice.

The medical profession, largely through your efforts, gentlemen, is awakening to the enormous task which industry has imposed upon it, and I want to assure you that the insurance carriers are steadily coming to as full a realization as you gentlemen and are willing and anxious to work with you in bringing about a situation in which the injured workman is given the benefit of the skill of the finest qualified surgeons, so that his restoration to health and strength shall be rapid and complete.

Workmen's compensation legislation has definitely placed the responsibility for the human wear and tear of industry upon the industry and through the industry, passes the cost on to the consumer. In administering the workmen's compensation laws the principle of insurance is vitally necessary. In no other way than by the strong helping to bear the burdens of the weak, could this great humanitarian reform be accomplished.

I should like here to correct an impression which seems to be to some extent prevalent, which is that the insurance companies make a great deal of money out of their workmen's compensation business. Nothing could be farther from the facts. The premium rates, in the majority of the states, require the approval of the State authorities, and it has been our experience that in many states, although we could show from statistics that our rates were fully justified for no fair reason, very often political, an arbitrary cut was made, sometimes as much as 50 per cent. In making the rates, we are allowed factors for the compensation payments, medical expenses and the expense of putting the business on the books and administering it. Not one cent is allowed for profit. The only profit we are supposed to get is

the interest earnings on the reserve we have to carry for unexpired business and unpaid losses. I assure you that in the past 10 years the companies' losses in the field of workmen's compensation have been very great. It may very readily be asked, if this is so, why do the companies continue to write it? For several reasons, one being the hope that the situation will improve, which it has done in the past 2 years, and another the realization that if it is given up the tremendous organizations the companies have to handle this business, built up at great expense of effort and money, would have to be scrapped, so with the optimism of youth we are looking to the next year to bring us some reward for our efforts.

The modern insurance company no longer considers it economy to organize its staff of surgeons on the basis of low fees. There is a sincere desire to give to the industrially injured the highest grade of surgical care that can be secured for him. Class consciousness still exists, and in many instances labor has been distrustful of the sincerity of employers and insurance carriers in this effort. Barriers of prejudice are being broken down, however, and as the years go by, we see a definitely increasing tendency on the part of workers to accept the good offices of employers or their insurance carriers, especially with reference to the treatment of injuries.

If the medical profession would only insist that industrial surgery occupy the same high ethical and professional plane that every other branch of the science does, and if insurance carriers and industry would come universally to the same conviction, each studying the problems of the other and trying sincerely and earnestly to meet them, most of the difficulties which now arise would be obviated. I want to ask you gentlemen to allow us to co-operate with you, to bring about this understanding and as time goes on, we hope that our co-partnership in a great humanitarian endeavor will accomplish great things.

cost of the first aid only. The majority of companies did not recognize that a man who had received proper surgical attention and made 100 per cent recovery could not secure as large damages for which the companies were liable as one who had been treated by an unskilled practitioner and as a result, was left with a permanent disability. It also reluctantly forces me to say that the companies did not in those days look at it from the humanitarian standpoint as they should have done, but in defense of the companies it can be said that they did not have much choice as the injured was allowed to have any medical man he desired. In the large majority of cases he had his own doctor who in many cases was not a surgeon, much less a skilled one, the result being disastrous to the injured. If the number of cases could be known in which a simple injury resulted in death, the loss of a hand or arm, a foot or leg because of infection or other complications due to careless or ignorant surgical attention we, I am sure, would be appalled.

Again I am sorry to have to admit that when workmen's compensation laws were first enacted, some of us at least did not recognize the importance, from either a humane or business standpoint, of seeing that the injured received the best surgical attention possible. I am glad to be able to say that that day has passed. The insurance companies and industry are rapidly getting the humanitarian viewpoint and though large financial institutions are popularly supposed to be without heart or soul they are still administered by human beings and it to me would indicate an impossible callousness for us to fail to recognize the vast humanitarian aspect of the whole problem of industrial injuries even before we grasp the financial significance.

We who are watching constantly the various phases of the workmen's compensation business, more particularly its medical aspects feel a crying need for an improvement in hospital facilities for the care of traumatic cases. We appreciate this need perhaps better than you gentlemen who are actually on the firing line because we are in a better position to view the problem in the abstract than are you. There are surprisingly few hospitals in this country who give any particular thought to the treatment of cases of *traumatism*. It is true that accident cases are well cared for in most of the hospitals but apparently there is a failure to appreciate traumatic cases as presenting problems quite different scientifically and psychologically from those encountered in general surgical practice. In my own city of Baltimore for example, I know of no hospital that maintains a

ward devoted to the treatment and study of fractures. It would seem that the rather unusual conditions which present themselves in cases of injury resulting from accident, the varied forms of treatment which are necessary, not to speak of the rather peculiar psychology often encountered in accident victims would lead the hospitals to provide special facilities for the care of such cases not only from the standpoint of physical equipment but also in the creation of supervising mechanisms, a careful check up on end results, and thorough study of cases from a scientific standpoint.

There is a need especially in our large industrial centers for fracture wards and wards for the treatment of traumatic cases, equipped with the varied forms of appliances necessary in this day of modern surgery providing opportunity for the practical education of medical students in traumatic surgery and providing the facilities for the post graduate instruction of graduates in medicine who may feel the need of it, and of these there are many. There are many problems involving the questions of infection, of fractures and of other phases of injury which are still unsolved and which offer productive fields for research. It is gratifying to see that interest in these matters is now being stimulated by the American College of Surgeons, and by a group of insurance carriers who have especially interested themselves in medical problems. Industry has thrust upon the medical profession a great burden and a great opportunity. Until now to a certain extent industry has failed to realize its own responsibilities in connection with the problem, but to no less extent has the medical profession also failed to grasp its true significance. Industry is now becoming conversant with the situation. The medical profession must work with industry in the provision of adequate care of the injured. It must realize that in participating in a field of activity which presents conditions and problems seldom met in the ordinary practice of medicine, it must undergo certain processes of readjustment. The medical profession will profit financially in its participation in the surgery and hygiene of industry, but it must adapt many of its traditions to circumstances which industry presents. Most of the difficulties which exist between the medical profession and industry are based upon a misunderstanding of the situation, of one by the other and often upon a stubborn refusal on the part of one party or the other, to attempt to reconcile conflicting views by yielding a point here and there.

The surgeon doing traumatic surgery must familiarize himself with the workmen's compensa-

tion laws. He is as much governed by those laws as the insurance carrier, the injured individual or the employer, and if he is going to participate in the whole scheme he must make himself an integral part of it in spirit and in practice.

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## MLDICINI IN INDUSTRY

HINNIAIACI AM MD DIH FACS DALLAS TEXAS

**I**N THE few minutes allotted to me I cannot discuss the lack of adjustment that exists between medicine and society, nor is it necessary to do so.

The remarks of many of the distinguished speakers on the program have already touched upon this important subject and these may be taken as an index of a widespread realization that, while medicine as a profession has more than lived up to its best traditions of self sacrifice, devotion and scientific endeavor, it has signally failed to adjust itself to the economic demands of society and particularly that part of society which is represented by industry.

Society in other words is fully satisfied with what medicine has made itself capable of doing but is utterly dissatisfied with its efforts—or rather its lack of effort—to transform its potential capacities into productive results.

The American College of Surgeons has set aside this day to search for ways and means of adjusting medicine to the needs of one particular class of society i.e. the working industrial class. It shall be my endeavor to point out wherein the lack of adjustment lies and to suggest a means whereby a proper adjustment may be effected.

The object we seek is to give adequate medical service to injured workmen but if we think of the problem in terms of the individual relationship between doctor and patient we shall end just where we started. The solution of the problem of how to benefit the injured workman is to be found only in a contemplation of the relation of medicine to the organizations which employ workmen and the organizations which exist to provide relief for workmen when they are injured.

The organization complex which is supposed to be created by the workmen's compensation acts, is the typical organization of relief. The employer, who insures his compensation risk with a carrier is the typical employer. There are half a hundred compensation laws in the various states but the Texas law may be considered as typical.

To simplify our problem let us confine our study to the relation of medicine to the Texas employer and his carrier in Texas in their united effort to create an organization complex for the benefit of injured workmen.

The Texas Compensation Act in common with all other organic laws, implies that an organiza-

tion complex shall be effected by certain factors which it designates to execute its purpose. A Board is provided for by law to administer the Act. These factors are as follows:

1. An organized body called the Employer which is held responsible by the Board for a report on every injury. If it fails to do so it is held to account and is subject to a large fine.

2. An organized body called the Carrier which must provide medical service to the injured, must pay a weekly compensation and must pay a specific amount of money to the injured man when permanently disabled. The Board holds the Carrier to a strict accountability for its acts.

3. An unorganized body of individuals—doctors—which is theoretically accountable to the Carrier, but which is in fact not responsible to anyone and which is in fact not accountable to anyone.

An organization cannot be said to exist unless it is a co-operative body acting under a single directing head. Is it not proper therefore to say that the intent of the Compensation Act to create an organization complex for the protection of the injured man in industry has utterly failed in that no control can be exercised over the doctor who is the chief active agent of medical relief?

Is it not a fact that the doctor in industry is not responsible to anyone and also that he cannot be held accountable by anyone?

a. Can the injured man hold him responsible? No. The injured man does not pay the bill and he is such a humble member of society that the doctor need not consider for a moment his capacity to affect the doctor's standing in the community. The doctor need not consider any protest made by the injured man.

b. Can the Employer hold the doctor responsible? No. The Employer is not the paymaster and he has neither time to investigate the character of medical service rendered nor the ability to evaluate those services if he did investigate them.

c. Can the Carrier hold the doctor responsible? No. The law provides that the Carrier must furnish medical attention and must pay the bills but there the matter ends. The dishonest doctor will, and often does refuse even to make a report to the Carrier. In some cases he exhibits his individualism and manhood by refusing to send

the Carrier a bill which he refers to the Board for collection. There is no existing power which can compel the doctor to account to the Carrier.

d Can the Board hold the doctor accountable? No. The Board has no power to compel any service from the doctor, nor can it call him to account. The Board may take the injured man out of the doctor's hands and it may require the Carrier to pay the doctor's bill, but there its power ends.

e Can the Courts hold the doctor responsible? Yes, if a suit is entered against him for malpractice, but the Carrier is the only one who is in a position to enter such a suit, and he may carry the doctor's liability risk.

f Can a doctor hold himself responsible and accountable? The answer is Yes. The conscience of the best doctors does hold them responsible and these doctors will willingly account for their acts. But all doctors are not the best doctors.

Society, as represented by industry, demands from medicine that it shall make its contribution to the organized effort of modern life and the answer to that demand has been that medicine will be responsible for service when it pleases and will render an account when it pleases.

Is it strange, therefore, that industry finds its medical service inefficient and expensive? Is it strange that the injured are not receiving proper care? Is it strange that carriers are actually losing money in the compensation departments of their business? Is it strange that organized labor and society at large are demanding in the name of humanity that the injured workman shall have a better chance to recover his ability to make a living? Is it strange that quacks and incompetents get hold of so many injured men? Is it strange that this lack of organization of medical service has brought about a condition whereby the misery of injured workmen is subject to an unholy exploitation by charlatans and shysters? It would be strange indeed if medicine's lack of organized effort had not created these conditions and it is amazing that labor, capital, and society at large have not long ago demanded as they are now demanding, that medicine shall either organize itself for economic service, or be organized by others.

#### HOW CAN MEDICINE BE ORGANIZED FOR SERVICE IN INDUSTRY?

I will remind my audience again that we are limiting our discussion to a consideration of industry as it exists in a single state, Texas, and as it exists under the provisions of the Texas compensation laws. The principles involved in our discussion apply, however, to the whole field of

industry, although other industries, such as the railroads which carry their own insurance, and industries in other States, all of which have different compensation laws may require different methods in applying these principles.

In Texas, as we have already stated, there are three factors concerned in the organization-complex which the Compensation Act relies upon to give relief to injured workmen. These are employer, carrier, and doctor. We have stated that the employer and carrier are held accountable by the Board and that the doctor, who is now independent of all control, must be made a responsible factor in this organization complex which the law intends to create for the execution of its declared purpose. Until this has been accomplished no real organization complex can exist. To answer our question, medicine can be brought into the organization complex created by the compensation law—

1 By an amendment of the law which would provide for state control of medicine. This is a form of *compulsory* organization which offends the dignity of medicine and is altogether a humiliating proposal.

2 By an organization created by the employer. This is a form of *compulsory* organization which must depend upon salaries paid to doctors to bind them to the organization. This form of organization may be practicable under certain conditions, but it is not possible under the provisions of the compensation acts where the carrier is the paymaster.

3 By an organization created by the carrier. As the carrier's business is scattered and shifting in character, it is not practicable to consider the formation of any organization bound together by payment of salaries. The carrier, therefore, is limited to a paper appointment of doctors to whom it requests the employer to refer the injured. This is an organization by *persuasion* and its efficiency depends entirely upon the cooperation the carrier is able to build up by tact, diligence, and persuasion. This is the common form of organization now existing in industry, but it is in fact no organization, because in its final analysis the doctor assumes only the responsibility he wants to assume and is accountable only when he wishes to be accountable. The existence of this Board on Traumatic Surgery and the fact that we are gathered together in conference today to devise ways and means to benefit the injured workman, are proof that this organization by persuasion is not satisfactory.

As a matter of fact, such an attempt is unsatisfactory and can be considered only as a make-



shift until such time as medicine can organize or be organized for service

4. The final method whereby medicine can be made available to industry is the American method of organization by *self determination*. Medicine is too fine, too competent, too efficient to permit of its duties being taken over by others. It is too proud to serve under a master and it deserves a better fate than that of loss of independence.

The solution of the problem of medicine as it relates to industry can be found, in my opinion, in an organization of doctors created and controlled by doctors which is competent to treat as an equal with the other factors concerned in the organization complex created by the Compensation Act to care for injured workmen. This is the American method of accomplishing an American purpose.

There is but one way for us doctors to organize medicine for service in industry and that is to do it. Can doctors do this? My answer is that doctors are like other Americans in that they can create power and are fully able to provide checks and balances to prevent abuse of power and yet accomplish the object for which power was created.

Tentative plans have already been drawn up for the creation of a medical association in Texas which have not yet been submitted to the profession at large but which have been discussed with leading surgeons, leading lawyers, employers and carriers. This is the first time these plans have been brought before the public.

It is planned that a body composed of the most honored and respected doctors in the state shall apply for the charter of an association formed primarily to guarantee adequate medical service to corporations to the state or to society when and where it is impracticable or impossible to secure, by individual contracts with doctors, co-operative and responsible service. The association would be empowered to charge for its services and to possess property, to publish a monthly medical magazine devoted to industrial surgery as a scientific study and to industry as it is mutually related to law, medicine and industrial medical organization. It would be empowered to rent or build and to conduct a scientific industrial laboratory and to rent or build a hospital ward in which the scientific treatment and study of industrial diseases and injuries could be carried on. It would have the power to establish either separately or in association with medical colleges, a course of medical instruction in laboratory, or practical, industrial medicine and surgery.

The immediate purpose of the association would be to offer its services to carriers to take over their entire medical problem. It would offer carriers the opportunity to make a single binding contract for medical service throughout the state to replace the present method of making individual contracts for service with thousands of doctors, none of whom is bound and none of whom can be held responsible and accountable.

To carry out its purpose the board of directors of the association would appoint a medical executive council, a medical director and a business manager. It would then draw up a set of by-laws and rules to which all members of the association would subscribe. These rules would provide for co-operative action of the members under the supervision of the medical director. With these rules in force and with the supervision of all injured which the association could and would provide for, the association could and would safely permit any reputable doctor to join the association as a member. It would then be up to the association to see to it that no doctor should be permitted to attempt treatments beyond his professional capacity, or where hospital and nursing facilities were inadequate.

The Compensation Act provides that unless the carrier fails, refuses or neglects to furnish medical service, no bills can be contracted in the carrier's name. It therefore follows that when the medical association has contracted with the carrier to furnish medical service and when this contract has been filed with the Industrial Board it can rule out and refuse to pay incompetents and all others who are not members of the association.

Having organized a state wide association the medical organization is then in a position to contract with carriers to take over their entire medical service. I will not go into the matter of furnishing bonds to the carrier, although this must be done.

The association could, in my opinion, reduce the cost of medical service to the carrier from 50 per cent to 25 per cent of its present cost within 2 or 3 years and as to the cost of compensation payments and the cost of settlements for disability, its service should enable the carrier to effect a reduction of from 25 to 30 per cent of its present cost. This saving would result from decreased morbidity, decreased mortality, and permanent disability but most of all from a decrease in fraudulent claims which are now costing huge sums to carriers by reason of the fact that there is no existing medical organization which

can be asked for an opinion which in court will outweigh and offset the evidence of purchasable false medical testimony. Several of the leading lawyers in Texas have pointed out that the proposed organization would at once place the whole profession of medicine on a higher plane of public esteem and would largely put an end to fraudulent suits and the quack doctor, upon whom the shyster lawyer depends for fraudulent testimony.

From the viewpoint of the profession, the proposed organization would be able to control the expenditure of large sums of money, much of which is now wasted by reason of the disorganized medical situation. Quacks and incompetents are making fortunes which should go to reputable, competent surgeons. Medical overhead of carriers now consumes large sums of money which can be saved when the single overhead of the organization takes care of the situation. The

association could not only save vast sums for the carrier, but it would pay for medical services what each case is worth.

Such an organization means added dignity to medicine, added income to legitimate medicine, an increased opportunity to study and treat industrial diseases and injuries, and an opportunity for medicine to become a valued member of the economic world. Such an organization would, I repeat, be an American instrument to serve America in an American manner.

Such is a brief sketch of a proposed organization designed to make our profession a part and parcel of the modern world of organized effort and a more useful member of society.

It is my hope and my ambition that this body, the American College of Surgeons, may accept my suggestion that the College is in a position to make the advancement of medical economic organization a part of its declared program.

shift until such time as medicine can organize or be organized for service.

4. The final method whereby medicine can be made available to industry is the American method of organization by *self determination*. Medicine is too fine, too competent, too efficient to permit of its duties being taken over by others. It is too proud to serve under a master and it deserves a better fate than that of loss of independence.

The solution of the problem of medicine as it relates to industry can be found in my opinion, in an organization of doctors created and controlled by doctors which is competent to treat as an equal with the other factors concerned in the organization complex created by the Compensation Act to care for injured workmen. This is the American method of accomplishing an American purpose.

There is but one way for us doctors to organize medicine for service in industry and that is to *do it*. Can doctors do this? My answer is that doctors are like other Americans in that they can create power and are fully able to provide checks and balances to prevent abuse of power and yet accomplish the object for which power was created.

Pentative plans have already been drawn up for the creation of a medical association in Texas which have not yet been submitted to the profession at large but which have been discussed with leading surgeons, leading lawyers, employers, and carriers. This is the first time these plans have been brought before the public.

It is planned that a body composed of the most honored and respected doctors in the state shall apply for the charter of an association formed primarily to guarantee adequate medical service to corporations to the state or to society when and where it is impracticable or impossible to secure, by individual contracts with doctors, co-operative and responsible service. The association would be empowered to charge for its services and to possess property, to publish a monthly medical magazine devoted to industrial surgery, as a scientific study and to industry as it is mutually related to law, medicine and industrial medical organization. It would be empowered to rent or build and to conduct a scientific industrial laboratory and to rent or build a hospital ward in which the scientific treatment and study of industrial diseases and injuries could be carried on. It would have the power to establish either separately or in association with medical colleges, a course of medical instruction in laboratory or practical, industrial medicine and surgery.

The immediate purpose of the association would be to offer its services to carriers to take over their entire medical problem. It would offer carriers the opportunity to make a single binding contract for medical service throughout the state to replace the present method of making individual contracts for service with thousands of doctors, none of whom is bound and none of whom can be held responsible and accountable.

To carry out its purpose the board of directors of the association would appoint a medical executive council, a medical director and a business manager. It would then draw up a set of by laws and rules to which all members of the association would subscribe. These rules would provide for co-operative action of the members under the supervision of the medical director. With these rules in force and with the supervision of all injured which the association could and would provide for, the association could and would safely permit any reputable doctor to join the association as a member. It would then be up to the association to see to it that no doctor should be permitted to attempt treatments beyond his professional capacity, or where hospital and nursing facilities were inadequate.

The Compensation Act provides that unless the carrier fail, refuses or neglects to furnish medical service, no bills can be contracted in the carrier's name. It therefore follows that when the medical association has contracted with the carrier to furnish medical service and when this contract has been filed with the Industrial Board it can rule out and refuse to pay incompetents and all others who are not members of the association.

Having organized a state wide association, the medical association is then in a position to contract with carriers to take over their entire medical service. I will not go into the matter of furnishing bonds to the carrier, although this must be done.

The association could in my opinion reduce the cost of medical service to the carrier from 30 per cent to 25 per cent of its present cost within 2 or 3 years and as to the cost of compensation payments and the cost of settlements for disability its service should enable the carrier to effect a reduction of from 25 to 30 per cent of its present cost. This saving would result from decreased morbidity, decreased mortality and permanent disability, but most of all from a decrease in fraudulent claims which are now costing huge sums to carriers by reason of the fact that there is no existing medical organization which

pled by the Department of Clinical Research of the College should be a valuable adjunct

6 The Department of Clinical Research hopes to fulfill an important and constructive function in acting as a clearing house in the consideration and standardization of new and approved methods of surgical procedures in treatment

7 It is becoming more and more evident that the work of the Board, like all endeavor for the advancement of human knowledge, must assume an educational character

How can instruction tending toward better traumatic surgery be promoted? If this accomplishment is to be realized there must of necessity be established a large, comprehensive teaching center or clinic for the accurate observation and treatment of injured patients. Such a clinic would be possible only in a densely populated community. The efforts of the Board can be crowned with success only by the construction of a large hospital in a great city where an abundance of teaching material is available and where both undergraduates and postgraduates can be taught. Obviously, such a hospital and teaching center must be entirely free from any self interested economic influence. Preferably it should be connected with a great university and be utilized for teaching purposes by the medical department.

Such an arrangement would insure its activity as a teaching center in perpetuity. Primarily the

interest of the Board is the welfare of the patient, which policy fortunately co ordinates with a general economic conservation, therefore, it would not seem too optimistic to believe that the budding of this proposed large hospital for the exclusive use of traumatic cases is a practical possibility and not an idle vision or dream

Financial support can be secured from many legitimate sources and because of the universal compensation laws such an institution might be made self supporting. Time does not permit the amplification of the potential possibilities in the advancement of surgical knowledge that will accrue from the centralization of a large number of traumatic injuries. It needs no diagram to permit the visualization of what could be accomplished

If the Board on Traumatic Surgery of the American College of Surgeons can consummate some such plan as outlined, it will have builded a permanent educational structure for the welfare of mankind. Without the realization of some such constructive, definite, practical plan for the advancement of surgical education, all of this discussion has a meaningless and hollow sound and will prove to be futile

The Board will assume the responsibility for executing its conceived program and the work will go forward with an optimism and an enthusiasm which will bring success

## HOW THE PROGRAM OF THE BOARD ON TRAUMATIC SURGERY ACCOMMODATES ITSELF TO THE PROBLEMS OUTLINED

IRVING A. BILLY, M.D., WAUKEGAN, ILLINOIS

Chairman, Board on Traumatic Surgery

**C**AN any program of the Board on Traumatic Surgery accommodate itself to the solution of the problems set forth in today's discussions?

This like many questions is easy to formulate and propound but the finding and the executing of the answer are much more difficult.

In today's discussions of the various phases and circumstances connected with traumatic surgery there has been some polite rhetoric but the clear and direct statement of facts has predominated. There have been shown a common understanding and a bond of community interest which argue well for the solving of at least some of the problems involved in securing better care for the injured. An optimistic feeling should prevail even though the difficulties of achievement are recognized.

The Board on Traumatic Surgery began its work 3 years ago. The object was to search for the facts, find the facts, analyze the facts, and arrange the facts to the end that they may be utilized in realizing some of the ideals for better care of the injured patient and in applying these ideals practically and effectively.

All of the research, all of the discussion indicate that there is no indiscretion in the conclusion that it is clear and unanswerable that the better, the more scientific, and the more intelligent management of the injured patient results in a greater economic saving for all concerned.

Some practical plan must be devised to supersede the present methods if we are to succeed in bettering existing conditions. How shall the Board proceed? The following campaign of attack is proposed:

1. Admittedly, the teaching of traumatic surgery in the medical schools during the past quarter of a century has not kept pace with the advancement in other branches of surgery. The amount of research devoted to injuries has been small and the follow up system inadequate. If we are to have better traumatic surgery then we must have medical men taught and trained in a manner commensurate with the demands that are made upon them. Contact with the deans of medical schools has been made and through their keen interest and ready co-operation the curriculum in several schools has been improved to meet

this educational situation. One of the most important functions of the Board will be to continue to co-operate with the medical schools in this work.

2. Correlating with the Department for the Standardization of Hospitals, a concerted effort has been made during the past years to secure a more complete equipment both as to personnel and materials for the better care of the injured patient. The result of this activity has been most gratifying. It has brought about an enormous improvement, and has shortened the stay of the patient in the Hospital by several days. The necessity and urgency for a continuance of this work cannot be overestimated.

3. The Board has adopted the policy of aiding the medical departments of large industries in every possible way and in this connection it has seemed wise to formulate a Standard for Medical Service and it will use every ethical and legitimate measure to secure its adoption. It is recognized, however, that many of the medical departments now existing exceed in their efficiency the Board's requirements.

Further, it is hoped that it will be possible to arrange for a group medical service that will be available to smaller industries so that they may have the efficient protection that the larger organizations now enjoy.

4. The significance and importance of the proper means for the transportation of the more seriously injured cannot be overstressed. The experience of the men working in France, the action of the Surgeon General in insisting upon the transferring of patients to distant centers where they could receive more competent supervision and the present practice of railroad surgeons would appear to justify the assumption that the moving of patients is not harmful even over considerable distance. Only through the centralization of patients and the collection of a large number of traumatic cases for observation and study at a place where all phases of their condition can be recorded, is there any hope for advancement and improvement of the present methods of treatment. This centralization of cases is most essential and has a direct bearing upon the principal plans and program of the Board.

5. The list of approved competent surgeons capable of caring for the injured that is being com-

piled by the Department of Clinical Research of the College should be a valuable adjunct

6 The Department of Clinical Research hopes to fulfill an important and constructive function in acting as a clearing house in the consideration and standardization of new and approved methods of surgical procedures in treatment

7 It is becoming more and more evident that the work of the Board, like all endeavor for the advancement of human knowledge, must assume an educational character

How can instruction tending toward better traumatic surgery be promoted? If this accomplishment is to be realized there must of necessity be established a large, comprehensive teaching center or clinic for the accurate observation and treatment of injured patients. Such a clinic would be possible only in a densely populated community. The efforts of the Board can be crowned with success only by the construction of a large hospital in a great city where an abundance of teaching material is available and where both undergraduates and postgraduates can be taught. Obviously, such a hospital and teaching center must be entirely free from any self-interested economic influence. Preferably, it should be connected with a great university and be utilized for teaching purposes by the medical department.

Such an arrangement would insure its activity as a teaching center in perpetuity. Primarily, the

interest of the Board is the welfare of the patient, which policy fortunately co-ordinates with a general economic conservation, therefore, it would not seem too optimistic to believe that the building of this proposed large hospital for the exclusive use of traumatic cases is a practical possibility and not an idle vision or dream.

Financial support can be secured from many legitimate sources and because of the universal compensation laws such an institution might be made self-supporting. Time does not permit the amplification of the potential possibilities in the advancement of surgical knowledge that will accrue from the centralization of a large number of traumatic injuries. It needs no diagram to permit the visualization of what could be accomplished.

If the Board on Traumatic Surgery of the American College of Surgeons can consummate some such plan as outlined, it will have built a permanent educational structure for the welfare of mankind. Without the realization of some such constructive, definite, practical plan for the advancement of surgical education, all of this discussion has a meaningless and hollow sound and will prove to be futile.

The Board will assume the responsibility for executing its conceived program and the work will go forward with an optimism and an enthusiasm which will bring success.

# COMMITTEE AND DEPARTMENTAL REPORTS

## DEPARTMENT OF CLINICAL RESEARCH

BOWMAN C. CROWELL, M.D. CHICAGO

Director of Clinical Research

**D**URING the year the Department of Clinical Research has been enlarged by the addition of the Committee on the Archives of Malignant Diseases and it now comprises

- 1 Committee on Bone Sarcoma
- 2 Committee on Treatment of Malignant Diseases with Radium and X ray
- 3 Committee on Archives of Malignant Diseases
- 4 Committee on Fractures
- 5 Committee on Standardization of Clinical Laboratories
- 6 Board on Traumatic Surgery

The departmental work connected with the functions of these committees has been carried on by a staff consisting of the director, one investigator, and an office force of two, sometimes three, clerks.

Reports of the work of the committees will be presented by their respective chairmen, but I take this opportunity of summarizing the outstanding work of the year in this department which has the supervision and correlation of the scientific activities of the College.

An ever increasing recognition of the work of the College in the cancer field has been a pleasing feature of the year's activities. This in my opinion, justifies the establishment of a Cancer Division of the department and I now make such recommendation to your Board. Three committees engaged on different phases of the cancer problem are able to summarize and make available present knowledge and experience gained from empiric sources and to contribute new facts as a result of their studies. The director represents the College on many committees of allied organizations engaged in the cancer problem and his position will be strengthened if he be known as the representative of the Cancer Division of the College.

Progress in the work on Bone Sarcoma is evidenced by the following facts: registration of 91 cases and records of 100 more cases awaiting registration or placing on the 'consultation list',

circulation of 525 cases among 31 interested persons, furnishing data for special studies to a number of students of the subject throughout the country, exhibits on the subject at several national meetings, numerous talks on the subject by the registrar at scientific meetings, and detailed studies of chondrosarcoma by the chairman and of Ewing's sarcoma by the registrar.

The Committee on the Treatment of Malignant Diseases with Radium and X ray has published two five year reports, and has participated in the establishment of cancer groups and cancer clinics in a number of cities that have been visited during the holding of the sectional meetings. The intimate contact that must be maintained with these groups will add materially to the work of the department, and should justify addition to its staff.

The Committee on the Archives of Malignant Diseases has held several meetings of its Chicago members for the purpose of organization of its work and is prepared to commence its activities as soon as a staff to carry on the work becomes available. Elaborate record blanks have been prepared for cancer of different organs and the distribution of these should have a beneficial effect on the nature of the histories taken in cancer cases. If the work of this committee is successful the College will have available a mass of information on cancer cases that could be obtained in no other way, and that will ultimately justify some conclusions on the relation of heredity to the incidence of tumors.

The Board on Traumatic Surgery has published the results of surveys of the present methods of caring for the injured in New York City and Chicago. Based on this purely objective study by a trained investigator, a standard for medical and surgical service in industry has been evolved and will be submitted to this body for approval. State committees have furnished to the Board the names of over 2,000 surgeons who in their opinions, merit inclusion on the list of traumatic surgeons to be approved by the College. From other

sources the names of about ten thousand other surgeons doing traumatic surgery in one form or another have been obtained and will need careful investigation. A symposium on the subject of traumatic surgery has been prepared for this Congress.

By authorization of this Board a number of surgeons are being admitted to Fellowship in the College under the classification of "Surgical Administrators."

The Committee on Fractures has held its annual meeting which will be reported by its chairman. A new feature was added to the sectional meetings in the form of the presence of the chairman of the committee and his active participation in all of

the meetings. At the cities visited, subgroups were formed to work in conjunction with the central committee and the names of these committees will be submitted to this Board for approval. A primer on the subject of fractures has neared completion, and a series of motion picture films on fractures is occupying the attention of the committee.

Emphasis was placed on the scientific work of the College at the Sectional Meetings, and this was facilitated greatly by the presence of members of the scientific committees. The attendance and interest of these members also made possible a very great extension of the influence and constructive program of the College work.

## COMMITTEE ON THE TREATMENT OF MALIGNANT DISEASES

ROBERT B. GREENOUGH, M.D., F.A.C.S., Boston, Chairman

### COMMITTEE

Robert B. Greenough, Boston, Chairman  
A. C. Broders, Rochester, Minn.  
Curtis I. Barnum, Baltimore  
George W. Crile, Cleveland  
Bowman C. Crowell, Chicago  
William Dumas, Boston  
Edwin C. Ernst, St. Louis  
J. M. T. Finney, Baltimore  
Burton J. Lee, New York  
Frank W. Lynch, San Francisco  
Robert T. Miller, Jr., Baltimore  
H. A. Pancost, Philadelphia  
H. Gilson Wells, Chicago  
Francis C. Wood, New York

I HAVE the honor to submit the following report of the Committee on the Treatment of Malignant Diseases with Radium and X-ray.

During the past year, five year end result reports were completed on cancer of the cervix and on cancer of the breast and these reports were published in SURGERY, GYNECOLOGY AND OBSTETRICS in August 1929. Preparation has been made to start the work of making abstract records of additional and more recent cases of these two diseases, together with abstract record of other cases of cancer of the rectum, colon, thyroid, and mouth.

In February and March 1929 Dr. Burton J. Lee, as a representative of this committee, accompanied the other officers of the College to attend the sectional meetings of the American College of Surgeons in Texas, Arizona, California, Oregon, Washington, Minnesota, Nebraska, Saskatchewan and Manitoba. Dr. Lee spoke at these meetings on the subject of cancer and of the work of the committee, and he was able to interest the

Fellows of the College in many of the cities visited in the organization of special cancer groups and cancer clinics in existing, approved hospitals, for the improvement of cancer service in these communities, and for the development and collection of material for further investigation of this disease. Plans are now under consideration for the further organization and coordination of groups and clinics of this nature, a most significant step in the improvement of cancer service throughout the country, and one which promises more than anything else immediately available to diminish the excessive mortality which is associated with this disease.

### SUPPLEMENTARY REPORT

In spite of world wide energetic research there is at the present moment, no indication of the discovery of any specific cure for cancer, and it is fair to suppose that for many years to come our present methods of treatment, surgery and radiation, will be the main reliance in the treatment of the malignant diseases.

Although either of these methods may be effective and successful in the treatment of early cases of cancer, especially in its more accessible situations in the late stages of the disease they are rarely of more than palliative value and there is evidence to support the estimate that not more than 10 percent of all cases of cancer are today given treatment in this early and favorable stage.

Much has been done to teach the public the importance of early diagnosis, but until recently it has not been appreciated that in most of its situations the diagnosis of early cancer requires personal experience and material resources far in



excess of those available to the general practitioner to whom the vast majority of patients first appeal when their anxieties are aroused by symptoms which they have been taught to believe to be suggestive of cancer.

This is briefly the situation that confronts us today, and we must either sit idly by and watch the constantly increasing harvest of death from cancer, or we must take such steps as lie within our power to meet this serious situation.

Research laboratories and cancer institutes throughout the civilized world are working on this problem and little by little the sum total of our knowledge of cancer is increasing. Much is being done also by the American College of Surgeons as well as by other organizations such as the American Society for the Control of Cancer, and through local state, and national medical societies and public health departments to improve our present resources for treatment by surgery and by radiation. There have been great advances in these lines in recent years, but to meet the difficulty of early diagnosis, further and more effective methods must be made available to the general practitioner in the way of easy consultation service, or all our efforts must go for naught.

The successful handling of early cancer cases has become a very restricted special line of medical activity requiring in the last analysis, not one man but a whole group of men acting in close co-operation and consultation. Too often the surgeon is unfamiliar with the results obtained by radiation and the radiologist with the results of surgery while both in many cases are without the close co-operation of the skilled tumor pathologist who is so essential to the wise selection of treatment in the individual case today.

Cancer institutes and cancer hospitals are already in existence in many of our larger communities today. There is room for many more such institutions and they will undoubtedly come into existence as soon as funds sufficient for their maintenance can be secured. They must always, however, be relatively few in number and thus inaccessible without undue delay and expense to the masses of the population and the great majority of the medical profession.

To meet this need, cancer clinics, established as a part of already organized hospitals, have sprung into existence in many places. Some of these clinics owe their origin to the initiative of interested members of the hospital staff. In other cases, as in Massachusetts, their organization has been fostered by the State Department of Public Health, and again the American Society

for the Control of Cancer, which has adopted the policy of development of cancer service, has had a share in the organization of clinics of this nature. At present there is no uniform co-ordinating agency in the development and maintenance of these clinics, but it would seem that such an agency is readily available in the American College of Surgeons.

The College already has a committee on the treatment of malignant diseases which has been engaged in promoting the more accurate and uniform recording of cancer cases, and in studying the comparative results of treatment.

It maintains the Registry of Bone Sarcoma and is undertaking the collection of data on heredity in the Archives of Malignant Diseases. All of these activities come under the Department of Clinical Research, and the organization of this department is amply qualified to take up this work. Provision can be made for a section meeting for those participating in cancer clinic work at the time of the annual meeting of the College, and another less formal meeting for the discussion of methods and policies could readily be held at some other time during the year, perhaps in connection with some of the sectional meetings of the college.

The provision of uniform record systems would greatly facilitate the collection of accurate data on cancer cases and thus contribute to the work already undertaken by Committees of the College and the *Bulletin* could be utilized to warrant close co-ordination of these clinic activities.

In the opinion of the committee on the treatment of malignant diseases this is a suitable and a desirable project for the American College of Surgeons to undertake. From the point of view of initial expense the cost to the College should be very slight,—limited indeed, to the increased labor required from the Department of Clinical Research. The clinics will be organized only in existing hospitals which have a sufficient professional talent and material resources to carry on the work successfully. Additional expense involved in conducting the clinics will have to be borne as it should be by the community they serve. The College will lend only the weight of its authority in promoting the principles involved in giving better cancer service to the community, and will offer a medium for co-ordination of effort and for maintenance of interest which will help the clinics to establish and improve their service.

The directors of the American Society for the Control of Cancer which is committed to the policy of measures such as this to improve cancer service, have passed a formal vote in approval





# REGENTS AND OFFICERS OF THE AMERICAN COLLEGE OF SURGEONS

Seated (left to right) Robert B. Greenough, Ernst A. Sommer, Miles F. Porter, Major General Merritte W. Ireland, President Franklin H. Martin, Director General George D. Stewart, G. A. B. Addy, Edward Martin. Standing (left to right) J. Bentley Squier, Charles H. Mayo, George W. Crile, Fred B. Lund, Perry G. Goldsmith, J. M. T. Finney, Allen B. Kanavel, Frederic A. Besley, Irvin Abell, C. Jeff Miller, W. W. Pearson, Admiral Cary A. Grayson, Bowman C. Crowell.

of the plan for the American College of Surgeons to take this action if they are disposed to do so. Your committee recommends, therefore

- 1 That the Board of Regents approve this plan for promoting cancer service in existing hospitals
- 2 That the name of the committee on the treatment of malignant diseases with radium and X ray be changed to read: The Committee on the Treatment of Malignant Diseases

3 That to this committee be entrusted the details of carrying out this plan and that an executive committee of six of the members of the above committee be constituted to work with the director of Clinical Research on the detailed methods to be employed

4 That the director of the Department of Clinical Research be authorized to act as executive officer of this committee and that a sufficient appropriation be made to his department to make it possible to carry on this work effectively

## COMMITTEE ON THE TREATMENT OF FRACTURES

CHARLES L. SCUDDER, M.D., FACS, Boston, Chairman

### COMMITTEE

Charles L. Scudder, Boston, Chairman  
 Nathaniel Allison, Boston  
 A. I. C. Ashburn, Philadelphia  
 Frederic W. Bancroft, New York  
 I. E. Barnett, Dundee  
 Willis Campbell, Memphis  
 Isidore Cohn, New Orleans  
 H. Earle Conwell, Birmingham  
 Cayetano Cordoba, Venezuela  
 F. J. Cotton, Boston  
 William Darrach, New York  
 Frank D. Dickson, Kansas City, Mo.  
 E. L. Flanagan, Philadelphia  
 William L. Estes, Bethlehem  
 W. E. Gallie, Toronto  
 F. B. Gurd, Montreal  
 G. W. Hawley, Bridgeport  
 Melvin Henderson, Rochester, Minn.  
 Paul B. Magnuson, Chicago  
 Lloyd Noland, Birmingham  
 W. O. Neil Sherman, Pittsburgh  
 F. A. Sommer, Portland  
 Kellogg Spied, Chicago  
 Jorge del Toro, Porto Rico  
 J. B. Walker, New York  
 John C. Wilson, Los Angeles  
 Philip Wilson, Boston

I HAVE the honor to present to the Board of Regents this the sixth annual report of the fracture committee. The educational work of the committee has progressed satisfactorily.

The *Fracture Primer* essentially completed has been submitted for publication and after careful editing will be published in the official organ of the College. The committee recognizes that the *Primer* will occasionally require revision and this task will be a perennial one.

**Graduate instruction.** A special fracture course given at the Massachusetts General Hospital, Boston, October 3 to 8 inclusive, 1928, was attended by one hundred and thirty-one surgeons from all parts of the United States and Canada. I have just come from a similar course on fractures given in Boston, completed Saturday evening, October 12.

Such intensive courses serve as stimuli and

examples to surgeons in other clinical centers. Similar courses are being contemplated in other cities under your committee's supervision. In Boston the participants giving the courses were members of the New England Regional Committee of the College.

**Undergraduate work.** We are in direct communication with the professors of surgery in A Grade medical schools. Dr. William Darrach, chairman of our subcommittee, addresses the Association of American Medical Colleges at its annual meeting in New York this month on instruction in fractures helpful to undergraduates. In view of the reorganization of the Presbyterian Hospital Fracture Unit at Columbia University, this address will be a constructive contribution.

**The fracture motion picture.** The first draft of the scenario on the treatment of fractures has been completed. The adaptation of the scenario is being perfected and those in charge of the production of the motion picture are in conference. The work is necessarily progressing slowly, but well.

**Inspection tour.** At the invitation of the College the chairman of your committee was able to attend the regional meetings of the College the past winter and spring. The scope and accomplishments of this tour so far as fracture treatment is concerned have been reported elsewhere.<sup>1</sup> Suffice it to say here that great interest was manifested in fractures throughout the country visited, and the names of the personnel of these committees will be presented to you for confirmation. Nineteen regional committee groups were formed. A more sure and thorough inspection of the fracture situation will undoubtedly result in even greater benefit.

**Steel bone plates and screws.** The fracture committee would like to be instructed as to the wishes of the College with regard to activity in connection with the standardization of steel bone plates and screws used in fracture work. Copy of

the report of the subcommittee was submitted to the regents

*New members* Certain new names have been proposed for membership in the committee and these, of course, will be presented in the written report. Dr. Joseph Blake has retired and so has resigned. Dr. A. I. Jonas, Omaha, is seriously ill and has retired.

As an example of the activities of members of our committee, the fracture exhibits at the recent meeting of the American Medical Association in Portland, Oregon, should be mentioned. The exhibits were supervised by a committee consisting of Drs. Speed, Allison, and Darrach with the assistance of an advisory committee.

Your committee is interested in appointing fellows to have charge of fracture exhibits at the several regional meetings of the College throughout the year. The personnel of these local committees will necessarily vary according to the place of the meeting. Dr. Kellogg Speed has

charge of the demonstration at the present meeting in Chicago.

The fact should be recorded that the Rockefeller Foundation has co-operated in furtherance of good fracture records by publishing a complete statement, illustrated, of the record form used at the Massachusetts General Hospital. A reprint of this article will be mailed to A. Grade hospitals. The College has offered to provide its address list for mailing these reprints.

The chairman of your committee this Spring attended the meeting of the American Railway Association, Medical and Surgical Section in Virginia. The relation of the railway surgeon to fracture treatment was discussed. As a result of contact with this important group of surgeons this association appointed a committee to co-operate with the fracture committee of the College in improving the treatment of fractures. Dr. Guthrie, of Sayre, Pennsylvania, is chairman of this committee.

## REGISTRY OF BONE SARCOMA

BOWMAN C. CROWELL, M.D., CHICAGO, REGISTRAR

### COMMITTEE

Dallas B. Fhemister, Chicago, Chairman  
Bowman C. Crowell, Chicago, Registrar  
Edwin I. Bartlett, San Francisco  
Joseph C. Bloodgood, Baltimore  
Harney Brooks, St. Louis  
E. A. Codman, Boston  
C. L. Connor, San Francisco  
James Ewing, New York  
W. R. Galbreath, Porto Rico  
Frank W. Hartman, Detroit  
Henry W. Meyerding, Rochester, Minn.  
J. J. Morton, Rochester, N. Y.  
Luis Razetta, Venezuela  
Channing C. Simmons, Boston

SINCE October 1, 1918, one hundred ninety-three cases have been received by the Registry, of which ninety-one have been registered. Of the remainder some will be registered and some placed on the consultation list. Four hundred eighty-five registered and forty-four unregistered cases have been circulated among thirty-one interested persons. There is a constantly increasing demand for groups of cases for study. One hundred seventy-three follow up letters covering three hundred forty-eight living

cases have been sent out to the surgeons registering the cases.

The present cases in the Registry fall under the following headings:

Osteogenic sarcoma	443
Benign giant cell tumor	20
Ewing's sarcoma	10
Myelomata	28
Metastatic tumors	37
Benign osteogenic tumors	74
Inflammation	57
Extrapariosteal fibrosarcoma	19
Angiomata	9
Angio-endotheliomata	6
Unclassified and miscellaneous	36
Giant cell tumor—malignant	5
Not bone tumors	18
Withdrawn	4
	<hr/> 1003

There have been exhibits on the subject of bone sarcoma at several national meetings, talks on the subject by the registrar at scientific meetings and detailed studies on chondrosarcoma by the chairman and by the registrar on Ewing's sarcoma.

## THE BOARD ON TRAUMATIC SURGERY

FREDERIC A. BESLEY MD FACS, WAUKEGAN, ILLINOIS Chairman

## COMMITTEE

Frederic A. Besley Waukegan Illinois Chairman  
 Bowman C. Crowell Secretary  
 John E. Bacon Miami Arizona  
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 Frederick J. Tees Montreal  
 John B. Walker New York

It is believed that the work of the Board on Traumatic Surgery has gone forward during the past year with steady and constructive progress and is becoming one of the important activities of the College. The progress has been made possible only through the far reaching vision of Franklin Martin, the Director General, who has recognized and supplied the material means for its accomplishments. It will be recalled that the original Research Group was appointed in 1926 and made its first report at Montreal.

Recognizing the necessity of obtaining first hand information and securing the real facts regarding the practice of traumatic surgery in all its relationships, which includes the injured patient, the employer, the hospital, and the insurance carrier, a comprehensive survey was made in the situations as they exist in New York, Chicago and the oil fields of Oklahoma. These surveys were made by Earl W. Williamson. His carefully prepared reports and his well thought out summary and suggestions will be found in the June 1929 and September 1929 *Bulletins of the American College of Surgeons*. This accurate information forms a substantial foundation for deductions and conclusions upon which to base an intelligent program for future activities.

## MEDICAL EDUCATION

It was realized that all real progress in the care of the injured depends upon improvement in the teaching of this subject and in emphasis placed upon it in the curricula of the medical schools, with post graduate courses as well. At the instigation of the Board on Traumatic Surgery, this subject was presented at the 1928 meeting of the

American Association of Medical Colleges held at Indianapolis, and a committee of that organization has been appointed, whose duty it is to see that emphasis is placed upon the teaching of the subject of traumatic surgery in the curricula of the surgical departments of the medical schools. The future influence that this will have cannot be overemphasized.

Obviously a state license to practice medicine is not always indicative of the ability and qualifications necessary to do competent traumatic surgery, and in this connection it may be fairly stated that all hospitals are not adequately equipped for the proper care of the injured. An attempt is being made by the Board to form a list of competent men throughout the United States who are eminently qualified to treat traumatic cases. State committees have been appointed to aid in securing this information and additional data regarding these men is being secured from hospitals, employers, and insurance carriers, and surgeons associated with large industries.

This information is being accumulated at the Clinical Research Department of the College and indexed on cards. At the present time there are listed the names of approximately 12,000 whose credentials and qualifications are known. Of these men, 8,624 are not members of the College. A large part of this information relative to their competency has been secured from the hospitals where they do their work.

Many requests have been made by employers of large numbers of workers as to what constitutes a proper medical set up for the prevention of accidents and sickness and the proper care of the injured.

Hospitals desire and require instructions regarding the necessary adequate equipment for the best care of the injured. Insurance carriers are evincing an ever increasing interest in the activities of the College in traumatic surgery and are willing to co-operate in the plans to secure better care for the injured. To meet this situation the Board on Traumatic Surgery is endeavoring to establish a high standard of proficiency for the prevention of accidents and sickness and the ultimate care of the injured and to utilize every ethical and legitimate means to secure the adoption of such a standard.

The Board on Traumatic Surgery at its meeting October 13 adopted the following standard

## STANDARD FOR MEDICAL SERVICE

This standard is to be required of industries, hospitals, insurance carriers and others desiring recognition and approval by the College.

1 A medical department devoted to the care of the injured shall be under the direction of a carefully selected physician who is responsible for the administration of the service and for the professional care of patients, subject to the approval of the governing body of the department. The personnel shall consist of at least (a) a competent physician, (b) a trained nurse or the equivalent, (c) a consulting staff of specialists officially appointed to advise and participate in the treatment of special cases.

2 The management of the medical department shall adopt rules and regulations governing the policies and the professional work of the department. These rules and regulations shall provide (a) that the principles of the Standard for Medical Service be adopted, (b) that there shall be prepared a monthly report which summarizes the nature and extent of the injuries and the results of their treatment.

3 Facilities for the treatment of the injured shall consist of (a) an efficient transportation service, (b) a casualty department in a hospital consisting of receiving, operating and recovery rooms adequately equipped for diagnosis and treatment, with accessible clinical laboratory, X-ray, and physical therapy services, all under competent medical supervision, (c) a system of case records, filed accessibly and cross indexed—a complete case record being one which includes identification data, cause of accident, nature and extent of the injury with detailed physical findings, special examinations such as consultations, clinical laboratory and X-ray, tentative diagnosis and prognosis with an estimated period of dis-

ability, progress notes and subsequent treatment, final diagnosis, condition on discharge and results, and additional information required by law in the case of a claimant for Workmen's Compensation.

4 Physicians designated to treat traumatic cases shall be (a) graduates of medicine in good standing and legally licensed to practice in the state or province, (b) competent in the practice of traumatic surgery, (c) worthy in character and in matters of professional ethics—in this latter connection the division of fees, under any guise whatsoever, shall be prohibited and (d) familiar with the principles of compensation law and contract.

5 Medical departments shall fulfill the requirements of the Workmen's Compensation law when treating employees of industry.

6 A hospital which maintains a department for the treatment of traumatic cases shall meet the Minimum Standard of the American College of Surgeons.

7 Sanitary conditions, accident prevention measures, and health supervision of employees shall be provided for in industrial and commercial establishments and in so far as possible to be under the general supervision of the medical department head.

At all of the sectional meetings of the College in the United States and Canada, the various phases of traumatic surgery have been discussed with interest and profit. The interest that the discussions of this subject has elicited at these meetings is worthy of comment.

It would be unfair to terminate this report without recognition of the thoughtful untiring industry and meticulous attention to detail of Dr. Bowman C. Crowell, secretary of the Board. He has made its work possible.

## STATE AND PROVINCIAL SECTIONAL MEETINGS

THE addition of certain features to the College activities with relation to the sectional meetings in 1929 served to arouse greater interest in them and to enhance their value. Representatives of the scientific committees of the Department of Clinical Research attended all meetings under authorization of the Board of Regents. In addition to presenting the work of their respective committees to the Fellows of the College, these representatives formed local subcommittees to function in association with the Central Committees. In the intervals between the formal sectional meetings the groups of visit-

ing officials visited other cities where they presented programs before the local county medical societies, visited the medical institutions, and also formed local subcommittees. The work on fractures, cancer and bone sarcoma thus received an additional impetus and increased its usefulness.

The hospital program was expanded to include practical demonstrations and discussions in the hospitals where local and general problems were discussed to the advantage and interest of all. A notable and pleasing feature of these meetings was a larger attendance of hospital trustees and their active participation in the program.

The following sectional meetings have been held in 1929

Arizona New Mexico Texas—Phoenix February 13-14  
California Nevada—Los Angeles February 18-19  
British Columbia Washington Oregon—Vancouver February 27-28  
Alberta Saskatchewan—Regina March 4-5  
Minnesota North Dakota South Dakota—Minneapolis March 11-12  
Nebraska—Lincoln March 14-15  
A clinical day and public meeting for Manitoba was held at Winnipeg March 7-8

In addition to the meetings just listed, programs were furnished for the following County Medical Societies

El Paso County Texas—El Paso February 11

San Diego County, California—San Diego February 15  
San Francisco County California—San Francisco February 21  
Portland City and County Oregon—Portland February 23  
King County, Washington, Seattle, February 25

The visiting speakers at these meetings included Drs Alfred W Adson, Rochester, Donald C Balfour, Rochester, Bowman C Crowell, Chicago, Carl H Davis, Milwaukee, Allen B Kanavel, Chicago, Philip H Kreuscher, Chicago, Burton J Lee, New York, William E Lower, Cleveland, Malcolm T MacEachern, Chicago, Franklin H Martin, Chicago, Charles H Mayo, Rochester, W W Pearson, Des Moines, Charles L Scudder, Boston, Rev C B Moulmier, S J, Chicago, and Mr Robert Jolly Houston

## REPORT OF THE BOARD ON MEDICAL MOTION PICTURE FILMS

THE Board has continued the work of surveying existing medical films for the purpose of securing information as to what films are available, where they can be obtained, and whether or not they are satisfactory for teaching purposes. About 250 reels of such film have been reviewed and catalogued at the office of the Board in Chicago.

To accomplish the purpose for which the Board was established, new films on practically every subject pertaining to medicine must be made. Leaders in the various branches of medicine. The Board of the College and the Eastman Teaching Films Inc. are co operating in the production of these films. Fifteen have been completed and approved, and copies of eight of these have been released for distribution. The others will be ready for release very shortly.

### APPROVED FILMS READY FOR DISTRIBUTION

*The Diagnosis and Treatment of Infections of the Hand* (3 reels) By Dr Allen B Kanavel  
*Benign Prostatic Hypertrophy* (1 reel) By Dr J Bentley Squier  
*The Technique of Blood Transfusion* (2 reels) Made at the University of Rochester Medical School  
*Indirect Inguinal Hernia* (3 reels) By Dr Daniel LeRay Borden, Washington  
*Simple Gout* (1 reel) By Dr George W Crile  
*Ectopic Heart* (1 reel) Photographed at the Kansas City General Hospital  
*Rabies* (1 reel) Photographed at Cook County Hospital by Dr Julius H Hess  
*Intestinal Peristalsis* (1 reel) Photographed at the Mayo Clinic by Drs Walter C Alvarez and Arnold Zimmerman

### APPROVED FILMS WHICH WILL BE RELEASED FOR DISTRIBUTION SOON

*Immotonia Congenita* (1 reel) An existing film which has been revised  
*The Normal Heart* (1 reel) An existing film which has been revised  
*Treatment of Normal Breech Presentation* (2 reels) By Dr Joseph B DeLee  
*Acute Appendicitis* (1 reel)—For the Public By Dr Edward Martin  
*Acute Appendicitis* (2 reels)—For the Profession By Dr Edward Martin  
*Tests of Vestibular Function* (1 reel) By Dr Richard H Lyman, Rochester N Y  
*Development of the Fertilized of the Rabbit's Ovary* (1 reel) By Dr Warren H Lewis, Baltimore

All of the approved films listed in these two groups were shown at the meeting in Chicago.

### NEW FILMS IN PROCESS OF PRODUCTION

*Fracture Film* (5 or 6 reels) By the Fracture Committee of the College  
*Water Pollution in Hospitals* (2 reels) By Dr Arnold H Kegel Chicago  
*Hospital Standardization* (2 reels) By Dr Malcolm T MacEachern Chicago  
*Cardiac Irregularities* (3 reels) By Dr Carl J Wiggers, Cleveland  
*Surgical Treatment of Pulmonary Tuberculosis* (2 reels) By Dr C A Hedblom Chicago  
*Massive Atelectasis* (2 reels) By Dr Walter Estell Lee, Philadelphia

Preliminary scenarios have been written for two or three other films, and a number of pictures showing operative technique have also been planned.



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translates from many languages—Dutch, Spanish, Italian, the Scandinavian languages, Bohemian, Polish, and Russian—considerable work being required in the languages of less importance in medical literature because of the broad field served by the College.

Co-operation with hospital libraries has become much more extensive during the past year. Representatives of hospitals have been given aid in establishing libraries in hospitals or, perhaps more important still, in planning for a more active service from a hospital library already established but more or less dormant. In hospitals where library service has been encouraged subjects have been selected for study and compilations have been made from the hospital case records combined with reviews of comparable data from the literature. The librarian furnishes information in connection with unusual cases in the hospital, answers questions from the laboratory, and is an important factor in the review of interesting cases or series of cases in the hospital staff meeting.

There are many opportunities for exchange of duplicate material between the College Library and the hospital library to the advantage of both. Thus coming year there will be published reg-

ularly in the *Bulletin* of the College a list of duplicates that can be furnished to hospitals and other libraries as exchange material and also a list of books especially needed in the College Library including bound journals required to complete files.

Instead of one or more outstanding gifts to the College Library during the past year, there have been smaller acquisitions too great in number to permit of listing in the available space. This is partly due to the fact that the Library has reached the stage where any extensive collection offered to the College is largely a duplication so that only a few volumes can be accepted from one source. There have been contributions from a larger number of the Fellows than ever before, the additions in many cases being the very latest publications and therefore most valuable in our research work.

The College Library should have a complete collection of the works of the Fellows of the College including two copies of all reprints for the Package Library section. Fellows of the College, especially those entering this year, are asked to send in copies of their books and articles and to keep such collections complete by the addition of new material as it comes from the press.

#### GREETINGS FROM THE COLLEGE OF SURGEONS OF AUSTRALASIA

Dr. JOHN NEWMAN MORRIS, Melbourne, Australia, Mr. President and Fellows of the American College of Surgeons: It is my privilege to convey to you today official greetings from the Executive Committee and a message of very heartfelt good will from the Fellows and members of the College of Surgeons of Australasia which includes New Zealand.

#### CHICAGO COMMITTEE ON ARRANGEMENTS

##### *Executive Committee*

Herman L. Kretschmer	Harry S. Gradle
Chairman	Carl A. Hedblom
Loyal Davis	Secretary
Joseph C. Beck	Allen B. Kanavel
Arthur H. Curtis	Philip H. Kretschmer
Vernon C. David	Ldwyn McGinnis
Carl B. Davis	Dallas B. Hemmister
	Alfred A. Strauss

##### *Clinical Program Committee*

T. D. Allen	Robert H. Buck
Arrie Bamberger	Howard R. Chislett
Harold Beard	Alice Conklin
E. A. L. Brown	Ralph C. Cupler

G. M. Cushing  
Irving S. Cutler  
D. J. Davis  
Marshall Davison  
E. K. Findlay  
James P. Fitzgerald  
Gilbert Fitz Patrick  
Arthur G. Frey  
Benjamin Goldberg  
J. A. Graham  
J. P. Greenhill  
F. P. Hammond  
B. C. H. Harvey  
Frederick Harvey  
Austin A. Hayden  
Ernest E. Irons  
Charles E. Kahle  
Arnold H. Keget  
Sumner L. Koch  
L. I. Kuhn  
Francis Lederer  
John Lindsay  
S. W. McArthur  
J. J. McGinnis  
Hugh McKenna  
R. W. McNealy  
A. R. Metz  
Karl A. Meyer  
Samuel J. Meyer  
Edwin M. Miller

Albert H. Montgomery  
Beveridge H. Moore  
Frank D. Moore  
I. D. Moorhead  
Laul F. Mori  
George Mueller  
George Musgrave  
Oscar E. Nadeau  
Edward P. Norcross  
O. B. Nugent  
Dwight C. Orcutt  
Daniel A. Orth  
Nelson M. Percy  
Charles H. Pfister  
George W. Post  
Emil Ries  
C. C. Rogers  
E. L. Ross  
Samuel Salinger  
Charles F. Sawyer  
V. L. Schraeger  
George H. Schroeder  
Hugh Scott  
George I. Suker  
George F. Tarnowsky  
George F. Thompson  
Arel Werelius  
Edward W. White  
Charles I. Wynekoop

A pamphlet prepared under the supervision of the Board, containing detailed descriptions of all approved films, is being sent out to medical societies, medical schools, hospitals, and Fellows of the College.

The production of the films already completed under our program has involved much experimental work in relation to such phases as lighting of operative fields, building of special cameras for photographing animated drawings and perfecting the use of panchromatic film and color filters to eliminate blood from the operative field. Everyone connected with the development of the work has gained much valuable experience, as a result of

and much future film productions will require less time and more satisfactory results can be accomplished.

The whole idea of utilizing motion picture films for teaching medicine and surgery has been given added impetus by the keen interest shown in the films exhibited at the meeting of the Clinical Congress in Chicago. Demonstrations made at that time of talking films resulted in much discussion of the possibilities of this method of teaching. It is the general opinion that the scope of the silent film is immeasurably widened by the addition of sound. Colored films shown at the meeting also offer interesting possibilities for further development.

## THE LIBRARY AND LITERARY RESEARCH DEPARTMENT

WHEN the College Library was initiated a research staff was organized to make this Library of use to Fellows of the College and to members of the medical profession in general. The development of the Library through each succeeding year has been accompanied by an even greater development in the service furnished by the associated Department of Literary Research. Requests are received from foreign countries as well as from all parts of the United States and material goes out by every mail, emergencies being met by telegram and air mail. For one doctor supplied with information in the reading room there are some two hundred served at a distance from the College Library. In each instance a definite outline of the doctor's requirements is followed, and according to this outline the work varies from the furnishing of a few references to the most comprehensive study of the subject. The service covers the compilation of bibliographies and the preparation of abstracts and translations or complete reviews of the literature to assist the doctor in his clinical work, in his experimental investigations or in the writing of his medical and surgical papers. Manuscripts of medical papers and books are edited and indices prepared of books ready for publication.

The loaning of books from the Library is reduced to a minimum because the College collection is required for the great amount of research work done in the College Library and also because most of the loan requirements are met by the reprint material in the College Package Library.

The Package Library is a classified collection of reprints and clippings from journals, selections from which are loaned on practically every subject put in work in the Department, and this section is in addition to the usual collection of books

and journals. Another division, more important still, is the file of bibliographies, abstracts, and translations that have been compiled since the Department and the Library were established some eight years ago.

The emphasis placed on service has definitely shaped the character of the medical library not only of the College Library but of local libraries in hospitals and clinics that have become more or less closely associated with the central Library. It has also brought a new type of worker into the field, the librarian who sees not merely a collection of books to be catalogued and cared for, but a fund of information which must be continually worked over to be made of practical use.

The College Library affords a training center for such librarians and continues to co-operate with them after they are in local service by furnishing material to complete the local library and by furnishing translations, editorial assistance, and help along any line that cannot be fully covered by the local librarian or research worker. Thus in addition to supplying the individual doctors directly the College Library and Department of Literary Research serves indirectly by supplementing the work in hospital libraries or the library and editorial departments of clinics.

The central Library must be more complete and the staff more comprehensive than in a local library. Because of the number and variety of requests received at the College, the Library has use for historical and other material that would be out of place and practically useless in the smaller local libraries where the limited space is filled with the most useful and recent selections.

In the same way the research staff at first including among their full time members only workers in English, German, and French, now

certainly cannot be accused of contributing to excessive cost of legitimate medical care

6 The public demands not only legitimate medical care of the best quality but when slight or serious illness comes, people are often reckless in their demands for extravagant rooms unnecessary nursing, and unwarranted consultations. These are often paid for by amounts in inverse ratio to their importance

Sickness is an unlooked for emergency and its cost, at any price, is looked upon as an embarrassing burden

#### MEDICAL AND SURGICAL ECONOMICS FROM THE STANDPOINT OF THE HOSPITAL ADMINISTRATOR

CHRISTOPHER G. PARNALL, M.D., Rochester, New York. Medical costs are only a part of the general advance in the present day standards of living. They stand out prominently because they come to the average person when he is least able to bear their burden. Doctors as a class, are not becoming unduly rich. Hospitals must struggle harder than ever to make up their deficits. Medical care becomes merely one of the multitude of factors in the high cost of modern living. The cost of preparation for medical practice has reached the point where one is appalled in considering it. It is getting so that only the well to do may contemplate medicine as a career. The doctor as a consequence, must make a just charge for his work, but should refrain from ordering expensive service without duly considering its actual necessity. Despite the fact that hospitals are having a hard struggle to provide within their budgets for necessary and desirable activities there is waste and unwarranted extravagance in the building and maintenance of some hospitals. Too often hospital building projects are undertaken in the spirit of excelling in physical form.

Probably the most feasible plan is a service organized and controlled by the hospital with limited professional fees or stated salaries for staff physicians. Unfortunately a considerable proportion of persons of moderate means fails to discriminate between the essential services of the hospital and those which are relatively unimportant. The cost of medical care is high but, before there can be any large reduction of costs some plan of co-operation which includes the doctor, the hospital, and the public will have to be worked out. The problem concerns not only the cost but also the burden of the cost. If the burden can be distributed the problem will be solved.

The Committee on the Cost of Medical Care, constituted as it is and enjoying the confidence generally of the public and medical profession is

perhaps the most logical group to which we may look for leadership. Simply stated the task of its members is, is it not, to propose a feasible plan for the distribution of the burden of the cost of medical care? The accomplishment of that task will be a difficult and momentous achievement in which the medical profession will justly share.

#### MEDICAL AND SURGICAL ECONOMICS FROM THE STANDPOINT OF THE NURSE

JANET M. GEISTER, R.N., New York. The nursing needs of the patient in modest circumstances must be met at a price which the average patient is able and willing to pay. Inextricably bound up in the problem of economics are the questions of availability and quality, of a graded service meeting all types of nursing needs, and of a nurse reserve for epidemics, disasters, and other periods of unusual stress. To the nurse the question of economics includes not only the need for a reasonably adequate income but reasonable hours of work and opportunities for advancement, for further study, and for some family and social life.

It is being demonstrated daily through visiting and student nurse work that the majority of our patients can be made comfortable and secure with an intermittent service. Both visiting nurse and student demonstrate that with intermittent service the personal relationship between nurse and patient can be constructively maintained. The waste of the general practice of continuous nursing care cannot be overemphasized.

It seems inevitable that for the great group of patients of modest means our nursing resources must be organized. Practically, this means organizing graduate staffs on salary for both hospitals and home patients. This would not preclude the employment of special duty nurses for continuous service if the patient could afford it, nor would it keep from the critically ill patient the continuous service he must have. A continuation of present individualistic methods of nursing offers no hope for a reduction in nursing costs. The nurse must have a decent reward for her labors and when this reward goes below the minimum standard accepted by the community for other workers, the end result is jeopardy of the patient. The well qualified nurse is forced into other fields. The present annual income of the private duty nurse has reached the lowest level compatible with any degree of safety to patient, nurse, and community. We can offer to the patient a uniform quality of nursing the amount based on his needs rather than on an arbitrary 24 hour day scheme, at a reasonable cost only if our present waste is eliminated and control and distribution are facilitated.

# HOSPITAL STANDARDIZATION CONFERENCE

## REPORT OF 1929 CONFERENCE IN CHICAGO

**A**N abstract of the papers and discussions presented at the Hospital Standardization Conference held during the Clinical Congress of the American College of Surgeons in Chicago October 14-18 1929 is presented in the following pages. Franklin H. Martin, M.D., Chicago, president of the College, presided. The distinguished guests were introduced by Surgeon General Merritt W. Ireland, Washington, D.C., president elect of the College.

### ADDRESS OF WELCOME

ARNOLD H. KEGEL, M.D., Chicago. Chicago is proud to have as its guests those who personify our highest ideals, the standard bearers of conscientious surgical practice and better hospitals. As a surgeon and as Commissioner of Health of the City of Chicago I extend to you welcome. Those of us who more recently have entered the field express our appreciation to the American College of Surgeons for our excellent training for the criteria set for our education, for standards of ethics and conduct in practice, for standards of professional aims and competency, and for efficient, well equipped, and well managed hospitals. As the need for competent surgery, for standardized hospitals, and for health inventories is filled, other problems will be taken in hand. A definite policy as to procedure and practice in the elimination of defects in school children and in the solution of our crime problem must be established. With a survey of the schools of Chicago as a basis, it is estimated that in the United States and Canada more than 15,000,000 children of school age are suffering the handicaps of correctable defects. In the correction of the physical and mental ills of children there will be found at least a partial solution of the seemingly insurmountable behavior problems of our youth.

A general appreciation of the higher standards set by the American College of Surgeons has made it possible for the legally constituted health departments to raise their minimum requirements. The International Society of Medical Health Officers has recently been organized, its objective being to raise the standards of public health administration and to co-operate closely with bodies

of like ideals. I ask consideration by this Congress of the possibility of a workable affiliation between medical health officers and standardized hospitals through the International Society of Medical Health Officers.

### MEDICAL AND SURGICAL ECONOMICS— INTRODUCTORY REMARKS

FRANKLIN H. MARTIN, M.D., Chicago. In arranging this symposium we have sought to bring together authorities who are interested in the economic solution of the cost of medical care—authorities who are in a position to know the facts involved and to estimate the bearing of these facts on the solution of this intricate problem.

The cost of medical care involves six fundamental factors: (1) the medical profession, (2) therapeutic measures, (3) the hospitals, (4) the laboratories, (5) the trained nurse, and (6) the demand of the public. A fair, judicious, thoughtful appraisal of these factors will be productive of competent evidence. The parts played by these various factors may be summed up as follows:

1. The average income of practitioners of scientific medicine is low compared to the income of other learned professions and is not to be considered as contributing heavily to what has been termed the high cost of medical care.

2. Legitimate therapies as prescribed by scientific, legalized practitioners, are reasonable in cost. Self-prescribing may lead to unreasonable expense. Excessive expense is often incurred through the use of patent medicines and so-called therapy as applied by irregular practitioners.

3. The average cost of routine hospital care is not exorbitant, even in face of the fact that we are in an age of extravagance and reckless expenditure.

4. Laboratory charges when limited to the generally accepted routine tests and to special tests actually prescribed by the legalized practitioners of regular medicine are reasonable in comparison with scientific laboratory work in the commercial world.

5. The fees of professionally trained nurses are far below the salaries of skilled workmen. They

more routine, and less scientific attention for the patient. There are schemes for governmental health and hospital insurance and it may be that eventually something of this sort will be evolved to aid in the solution of the problem. As a matter of fact, the hospital is a community asset, not a profitable business, and must be accepted as such.

Personally I believe the 2 year course of nursing as a minimum would have been better for the average nurse than the 3 year course. The routine 2 year course would not be relished by the hospital authorities, who profitably absorb much time and labor from the nurse in training. I would not establish an upper limit of nurses training but would encourage all those who had the desire and ability to take 3 or 4 years of training, just as medical students are encouraged to take post graduate work. The special work for nurses would fit them to fill superior positions.

Patients at the upper end of the financial scale, whose economic condition warrants it will continue to have two nurses, 12 hour or 8 hour duty, or whatever they desire, the more the better. I shall be pleased to see the nurses get jobs. For the common man the hospital should employ the nurse and use her in superior positions and when necessary at an extra charge sufficient to cover the cost of semi private care of several patients. Her fine training is wasted in scrubbing floors, making beds, giving patients baths, and doing many other tasks that a hospital maid could be trained to do in 6 months. The nurse has had superior training, she should have a superior position with reasonable hours and certain pay.

I believe the financial burden of sickness on the common man so far as hospital and nursing care is concerned could be greatly reduced by properly planning and equipping hospitals by introducing economical methods of caring for the patients and by compelling the proper authorities to pay for the care of those unable to meet the expense. The municipal or county authorities should not sponge off funds from the charitable minded or add to the burden of the sick already overtaxed.

#### COMPARISON OF MEDICAL AND HOSPITAL COSTS FOR INDIVIDUALS IN MODERATE CIRCUMSTANCES

STEWART R. ROBERTS, M.D. Atlanta. The patient in moderate circumstances is to the hospital a business proposition. When sick he must have service in proportion to his sickness, no matter what his means. It is the sickness and the cure that count with the wealthy patient while it is the sickness, the cure, and the cost that count with the patient of moderate means.

It is difficult to state the relation between medical fees and hospital costs for patients in moderate circumstances. The problem involves many elements—the patient, his thrift, the length of his stay, the kind of room or bed he accepts, whether or not he has an operation, X ray, or laboratory examination, whether or not a trained nurse is employed, and whether the physician charges his regular fee without relation to the circumstances of the patient, reduces his fee to fit the financial circumstances of the patient when he enters the hospital, or scales it still lower in consideration of the depleted means of the patient when he leaves the hospital. Another factor to be considered is whether the patient recovers and is able to work in order to pay his medical fee, or whether he dies and leaves a family without support. Generally speaking, in a short illness, the hospital fee is from one third to two thirds of the medical fee. In an illness of moderate length, say 2 weeks, the fees are approximately the same. In a long illness the hospital fee is much larger than the medical fee.

#### GENERAL SUMMARY, WITH SPECIAL REFERENCE TO THE INFLUENCE OF UNIVERSITY DIAGNOSTIC CLINICS AND THEIR BEARING ON THE FEES OF INDEPENDENT PRACTITIONERS

RICHARD R. SMITH, M.D., Grand Rapids. The increased cost of sickness is a heavy burden to people of moderate means, and workers in the field of health should endeavor to make this burden lighter. At the same time the practice of scientific medicine must go forward. The doctors want the public to receive the best possible hospital service at a cost commensurate with such service. The doctor emphasizes the professional and scientific side, and the patients the nursing and household comforts to which they are accustomed. Some want privacy and a special nurse which increases their bills enormously.

Regarding costs as a whole, the hospital should be economically run, the hospital authorities have the urgent responsibility of seeing that the cost to individual patients is justly distributed and that no patient pays for more than he actually receives estimated on a sound, fair basis. Most hospitals are run economically but not sufficient emphasis is placed on essentials. A credit bureau in each hospital for the investigation of the patient's finances and a schedule of charges which seems just and reasonable are essential.

In the university clinic the doctor sees an endorsement of state medicine which eventually may prove to have serious effects upon private practice and upon the health of the public which the

This means an organized graduate nurse staff which will offer to the nurse the things she should have—a reasonably adequate income, a shorter working day, opportunities for study and advancement, and constructive leadership. The present individualistic form of service provides no machinery for obtaining these things.

#### THE RELATIONSHIP OF MEDICINE AND ITS AIDS TO THE COST OF MEDICAL CARE

REV. ALPHONSE M. SCHWITALLA, S. J., Ph. D., St. Louis. The unique and privileged position of the physician in his dealings with his patient has been radically and, in all probability, permanently invaded. The nurse, the hospital authorities, the dietitian, the social worker, all have something to think and to say, independently of each other, concerning the welfare of the patient. The nurse is gaining in her progress toward professional autonomy. The dietitian is carrying on a crusade for a recognition of her position in dealing with the sick. The social worker, too, is suggesting that she has an independent contribution to make toward the study and care of disease. The laboratory worker has given more than a hint that his or her function is not merely to aid in diagnosis but actually to voice an opinion in therapeutics.

Obviously, the sick human being is an interesting object of study. Not only the physician's efforts but the efforts of all his assistants have made our people progressively health-conscious, and as a result of enormous propaganda there now exist countless health activities which 20 years ago either were unknown or, if known, were relatively insignificant. We are confronted with the fact that the sick man is surrounded by a swarm of officials and semi-officials each to be sure fully capable of adding greatly to the comfort, peace of mind, and health of the patient, yet each fully conscious that he has a right to an adequate financial reward for the services which he renders—a reward, too, commensurate with increasing standards of education and experience. Is it any wonder, therefore, that an economic problem of enormous magnitude has arisen from our health activities?

If the costs of illness are to be decreased one or more of four cost factors must necessarily be depressed, namely: (1) the hospital costs, (2) the physician's fees, (3) the nursing costs, and (4) the cost of accessories. The hospital has I believe successfully vindicated itself against the charge that it is a money-making and avaricious institution. We have numerous pronouncements from physicians in various parts of the country in which

the charges for medical care are vindicated as far as the nurses are concerned it may be granted, without fear of contradiction, that the present scale of prices for nursing service is generally speaking, anything but exorbitant. And what about accessories? The incidental hospital expenses, such as the cost of medicines, operating rooms, fees for anesthetics, laboratory work and other extras, all combined represent, as closely as we may judge, one fifth of the cost of illness. Even if we were to reduce these expenses by one half we would have reduced the total cost of illness by not more than 10 per cent. Here then is our economic problem in so far as it relates to medicine: the hospital cannot reduce its charges, the physician must not be asked to do so, the nurse can not do so, and the cost for accessories may be reduced at most by only 50 per cent. Clearly, we are confronted with a problem which is intertwined with our whole economic system, and, until the large and comprehensive study now in progress has been completed, any suggestion of a radical character would seem untimely.

#### NURSING AND HOSPITAL COSTS FOR INDIVIDUALS IN MODERATE CIRCUMSTANCES

WILLIAM J. MAYO, M. D., Rochester. There are two classes of patients to whom the expense of hospitalization presents no problem: the 15 per cent of the population at the upper end of the financial scale to whom the cost is an unimportant detail and the 15 per cent at the lower end of the financial scale who are essentially objects of charity. Of the intervening 70 per cent, 10 per cent toward the upper end, at some inconvenience, can continue to carry the financial burden and 10 per cent near the lower end cannot pay their doctors but can pay something toward hospital costs. The intervening group, comprising at least half the total population, finds the cost of hospitalization and nursing a burden which can be met, if at all, only by a very considerable sacrifice.

Supersalesmanship is sometimes found in the hospital. The patient is placed in surroundings which however much they may appeal to his aesthetic sense are above his means and have no value in relieving the condition from which he is suffering. The patient in a well planned ward which gives a moderate degree of privacy will make a quicker recovery, as a rule, than the patient in a private room with two attentive nurses.

State medicine has worked wonders in the prevention of disease. It has added 18 years to the average human life. However, for the state to take over the care of ordinary illness would introduce civil service mediocrity, more drugs

carry out the policies of the institution as approved and authorized by the governing body

4 An adequate and efficient personnel, competent in the various fields to carry out the details of management and administration under proper supervision, and responsible to the chief executive officer of the institution

5 An organized medical staff of ethical, competent doctors to determine, develop, control, and carry out the professional policies of the hospital subject to approval of the governing body

6 Adequate diagnostic and therapeutic facilities with efficient technical service, under competent medical supervision

7 For all patients treated, accurate and complete case records, cross indexed and filed in an accessible manner so as to be available for future study, reference, and clinical research

8 Group conferences of the administrative officers and medical staff to review regularly and thoroughly the activities of their respective divisions for the purpose of keeping the service and scientific work on the highest plane of efficiency

Some of the outstanding results of Hospital Standardization are

1 The shortening of the patient's stay, now generally ranging from 8 to 15 days, with an average of 11.5 days, a decided improvement over that of 10 or 12 years ago

2 The lowering of hospital mortality rates to a range of 2 to 6 per cent with an average of 3 to 3.5 per cent, a vast improvement over the percentages of 10 or 12 years ago

3 The lessening of the incidence of infections, complications, and secondary conditions, as revealed by hospital records and statistics

4 The increasing number of consultations, promoting better diagnoses and therapy

5 The increasing number of autopsies, making the practice of medicine more thorough and accurate

6 The group study of certain diseases based on the clinical records of the hospital

7 The increasing interest in teaching and clinical research manifested by the medical staff and hospital management

8 The greater use by the medical staff of diagnostic facilities, such as the clinical laboratory and the X-ray, to assist in making or confirming diagnoses

#### Discussion

N P COLWELL, M D, Chicago In the past 50 years there have been more remarkable advances in medicine than in all previous time

There has never been a time when nations around the globe have been so free from epidemics as at present. Instrumental in advancing the practice of modern medicine have been the hospitals. With the rapid development of these institutions, it is not surprising that some have not gained all the equipment and other essentials for a good hospital. However, the different hospital agencies are all working for the same purpose—the best possible service to the sick and injured. We must all work together for this worthy cause. The splendid co-operation which has been shown since Dr. MacEachern has been in the work must be continued.

#### THE SUPERINTENDENT'S VIEWPOINT OF THE NURSING PROBLEM

PAUL H FESLER, Minneapolis The present day nursing problem is (1) to reduce and improve the supply of nurses, (2) to replace students with graduates, (3) to help hospitals meet the cost of graduate service, and (4) to get public support of nursing education. The Committee on the Grading of Nursing Schools is now studying questionnaires to ascertain actual conditions in the personnel of schools of nursing, to the end that the number of schools and possibly the number of students may be greatly reduced.

The American College of Surgeons after 10 years has reached a very small percentage of the smaller hospitals. More than 50 per cent of hospital beds are in towns of less than 10,000 and 61 per cent in towns of less than 25,000. In Minnesota practically every community has a modern hospital with modern equipment. However, it is difficult to get nurses to go into such communities, for a nurse trained in a large, modern hospital craves the continuous activity to which she is accustomed. It is not imperative that these small hospitals have nursing schools, but many have to conduct schools in order to have a nursing service.

The large hospital faces problems which have resulted from propaganda regarding the cost of medical care to the middle class—which cost usually begins and ends with the hospital bill—but all hospitals of any importance have good service for the middle class patient. Hospital costs are simply keeping up with the advance in medicine. This increased cost can definitely be divided into two parts: (1) service—primarily nursing service—and (2) education. The added expense is more than covered in the saving of time to the patient and in increased efficiency, since hospitals are insulating many time and labor saving devices. The patient now spends 10



doctor serves. In order to teach the students the university medical school needs material and receives into its hospital those who are supposed to be unable to pay more than their hospital bills. These clinics have grown enormously until today many patients are admitted to the out patient departments and hospitals who could pay small or moderate fees but who receive professional services for nothing, thus taking from the practitioner a considerable amount of income.

### Discussion

BIRD S. COLTR, New York. We must draw a line between public and private duty. The city, county, or municipality should pay in full for charity and welfare patients in all hospitals and not leave this work to private charity. From the standpoints of efficiency and economy, the standardization of hospital equipment, supplies and procedures is of great importance at this time. Much money is needlessly spent on hospital equipment which might be saved if there were well established standards to guide the hospital management. Herein lies a big field of endeavor for this organization which is serving the hospital field so splendidly.

C. JEFF MILLER, M.D., New Orleans. One of the problems facing us today is the question of the charity patient. Why should the physician as an individual or as a member of the medical staff have to assume responsibility for the charity patient? This patient should have proper care at the expense of the public—a community responsibility not to be borne by the physician in his personal or individual capacity.

MALCOLM T. MACEachern, M.D., Chicago. I fully believe that hospitals generally are being efficiently administered and doing all possible to keep down costs for the patient of moderate means. Most hospitals do 12 to 20 per cent charity work and frequently without subsidy or special funds to pay for it. The liquidation of this liability may sometimes mean higher charges to paying patients. Every hospital doing charity work should have subsidy from the municipality, county, or state, or some special fund or endowment to pay for this work and prevent its being a burden on the regular budget.

In the planning of hospitals costly administration may be saved through small easily cared for rooms or cubicles, with the service convenient to the patient. A wide range of accommodation suited to the varied financial means of the patient is most desirable. Flat rates for services group nursing, and the standardization of equipment, supplies, and procedures, all tend to keep hospital

charges within the limit of the patient of moderate means. In all our discussions and possible reform let us always keep the best interests of the patient in the foreground lest we become callous, inhuman, or mercenary.

### OFFICIAL REPORT ON HOSPITAL STANDARDIZATION FOR 1929, 12 YEARS IN RETROSPECT

MALCOLM T. MACEachern, M.D., Chicago. During the year over 3,600 general and special (excepting mental and tuberculosis) hospitals of 25 beds and over were on the survey list of which 2,855 were considered for approval. These were grouped as follows: (a) 100 beds and over, 1,334; (b) 50 to 99 beds, 974; (c) 25 to 49 beds, 547. Of the total, 1,969 were awarded full or conditional approval, leaving 886 which were not approved. Certificates of approval have been awarded to 1,403 hospitals prior to October 1, 1919. This year 18 hospitals which have lost their rating of full approval will be requested to return their certificates for failure fully to comply with the requirements. The total bed capacity of the hospitals under survey is 409,350 of which 339,169 beds are in approved hospitals. This means that approximately 7,183,380 patients spent at least 82,200,560 days in approved institutions during the year.

Hospitals are classified as follows: (1) not approved—the hospital which does not accept or meet the requirements in any respect; (2) conditionally approved—the hospital which has accepted the requirements and is endeavoring to meet them, but for lack of time or other acceptable reasons has not been able to carry them out in full detail; (3) fully approved—the hospital which has met all the requirements and is carrying them out in an acceptable manner; (4) certified—the hospital which has been fully approved for sufficient time to assure the American College of Surgeons that it will conscientiously live up to the requirements at all times and has therefore been granted a certificate of approval.

The eight fundamental principles of Hospital Standardization are:

1. A modern physical plant free from hazards inimical to the patient's welfare and safety, properly furnished and equipped for the comfort and scientific care of the patient.

2. A carefully selected governing body representative of the best community interests in which body is vested complete and supreme authority for the management of the institution.

3. A competent chief executive officer or superintendent with authority and responsibility to

by providing the proper facilities and by encouraging the student to take advantage of them.

If the hospital is sectarian, moral education can be obtained by religious training. In Catholic hospitals this is particularly easy for they can make a direct appeal to the students through the fundamental tenets of their religion. In hospitals of a non religious type the moral training must be attained by bringing the student to a proper realization of, and respect for, her work.

The best means of insuring efficient care for the patient is through the maintenance of a high grade nursing staff. And this, in turn, is insured only by the proper type of education in our schools of education which makes for well balanced graduates who regard their profession not as a means of earning a livelihood, but rather as a sacred calling and who, while caring for the physical, mental, and moral needs of the patient, find divine inspiration for their work in the words of the Master: "Whatsoever you do unto the least of these, my brethren, you do also unto Me."

#### Discussion

ADDA ELDREDGE, R N, Madison. All state studies tend to prove the report of the Grading Committee correct. A small study in my state has proved the oversupply of nurses. The Grading Committee's report is based on the fact that there is an oversupply of nurses, very poorly distributed. It is undoubtedly true that many people are not properly nursed, even when many nurses have no work to do. Small hospitals are increasing in number and nurses must be provided for them. Graduate nurses will be glad to nurse in small hospitals if the working conditions are satisfactory. The superintendent of nurses must be as capable in the small hospital as the large. Often greater ability is required in the small hospital for in the large hospital things are usually well organized. Proper living conditions, a graded salary, and a plan for staff education are necessary. In small institutions so many graduate nurses would not be required if there were a carefully graded service with attendants or maids under proper supervision, who were not permitted to render nursing care, which should be given by only the nurse herself.

In the general discussion which followed, several speakers commented on two important matters: (a) the discontinuance of the monthly allowance to student nurses and the diversion of the money to nursing education—a plan favored by many present, and (b) the obtaining of better qualified instructors in schools of nursing to avoid the frequent anomaly of the student

nurse with a more extensive background of education than her teacher. A strong plea was made for higher educational standards and pedagogic proficiency in schools of nursing.

#### STAFF CONFERENCES

WALTER S. GOODALE, M D, Buffalo. In recent years appreciation of the value of group thought and action has penetrated the practice of medicine. No one man or woman can know everything about medicine, which daily becomes a more complicated science and art. Therefore, conferences of various kinds have been introduced into hospital practice, thus making diagnoses and therapies more communal concerns than individual, as heretofore.

The minimum number of staff conferences for each hospital should be one a month but weekly meetings are better. The large hospital may hold a monthly general conference and more frequent departmental conferences, including the pathological. There cannot be too many conferences if they are all instructive. In the Buffalo City Hospital, we take particular interest in the internes' conference, 1:00 to 2:00 p. m. daily, for the discussion of all serious cases in the hospital. This is most valuable in our type of institution, not only from the standpoint of care of the patient but for the education of the interne. All staff conferences should aim at improving the service for the sick and injured and the education of the medical staff.

#### Discussion

JOHN T. BURRUS, M D, High Point, North Carolina. We have a weekly staff conference which everyone must attend. Cases terminating in death are discussed. Every autopsy is fully discussed. Inquiries are made into any infections occurring in clean cases. All cases which are not doing well are discussed from every possible angle. We do not exempt from the staff conferences our nurses, laboratory technicians, anesthetists, or instructors of nurses. I think the greatest and final test—the acid test—of any institution is the determination of the extent to which it can lower its death rate. If the records of an institution show a high death rate then there must be something wrong.

#### STAFF CONFERENCE DEMONSTRATION

The medical staff of Ravenswood Hospital, Chicago, some 15 in number, under the leadership of Dr. E. B. Williams, chairman, gave a most interesting and instructive demonstration on how to conduct the staff conference, beginning with the

or 12 days in the hospital, whereas he formerly stayed 25 or 30 days. The patient satisfied through an efficient nursing service is the best advertisement for a hospital so it is imperative that the hospital maintain an interest in this service. The hospital should contribute something to education for if good service is rendered this will be reflected in a substantial way bringing in money which can be spent for buildings and education alike. The patient should not pay for the education of nurses. Most of the large hospitals receive endowments or gifts and by appealing for funds for education will undoubtedly obtain sufficient for their needs. Some of the best nursing schools, whose standards of admission have long since been raised, are in large private hospitals.

Some 12 or 13 of the larger universities have organized the 5 year combined course in nursing but only a small percentage of the students take the 5 year course. Only 1 university—Yale—does not give the 3 year course. Of the enrollment of 500 in the University of Minnesota only about 85 are 5 year students but they leave school with the same standing as any other nurse who passes the State Board examination. The university should contribute to the welfare of all the people of the state even the patients in small hospitals. Such an end could be achieved in small hospitals by setting standards for their nursing schools which would have to be met before their graduates could affiliate with the larger hospital. Many small hospitals could not meet such standards and some would continue with unapproved schools, but if the university and larger hospitals would train public health nurses and send them into the remote districts they would have considerable influence on the smaller hospitals and, to some extent relieve the situation. There is no question that in adjusting this matter the patient must be the first consideration and the movement for better nursing schools will not succeed if it does not reach the rural districts.

#### HOW CAN WE ASSURE EFFICIENT NURSING CARE OF THE PATIENT?

E. MURIEL MCKEE, R.N. Brantford Ontario  
In any hospital the careful selection of the nurse, a sufficient number of nurses and adequate equipment and supplies are imperative to assure good nursing care of the patient. There is the hospital which does not maintain a school for nurses but employs graduate nurses to care for patients. If the hospital enjoys a good reputation is well organized and equipped, and offers proper remuneration, it is not difficult to secure a good nursing

service. In this day, however, the hospital affiliated with a university school of nursing is becoming more prominent and offers the following two distinct problems: (1) the care of the patient and (2) the education of the nurse. As the demand for hospital accommodation has increased new hospitals have been built and new wards and departments added to those already in existence. In many of the new hospitals training schools for nurses have been established, while those already existing in the old hospitals have been greatly enlarged. The growth of a school for nurses should be determined by the quality and reputation of and demand for its graduates, rather than by the growth of the hospital. The careful choice of student nurses—selecting each one on her merits and qualifications and not because a definite number must be secured—is one of the surest means of obtaining efficient nursing service. Student nurses under proper supervision often cannot meet the demand because their service is continually interrupted. There are certain patients whose physical condition demands the skilled services of a graduate nurse, but the high cost of this type of service has resulted in a new service in hospitals which is proving very satisfactory, commonly called 'group nursing,' which means that the divided attention of graduate nurses is offered, the patient securing their service at much less than the cost of a full time "special nurse."

There are certain very definite prerequisites to efficient and economical care of the patient, with out which the most capable nursing staff is unsuccessful. One of the first considerations is the conservation of time and physical effort, and if every ward in the hospital were a complete unit—a special hospital so to speak for the type of patient it cares for—thus could be realized. The employment in sufficient number of ward helpers and well trained orderlies to do the routine work is a sound economic measure. The present day careful planning of new hospitals and reconstruction of old ones also mean more efficient nursing care for the patient.

SISTER HELEN JARRELL Chicago 'Efficient nursing care' is defined as aiding the patient physically, mentally and spiritually or morally, the two latter—mental and spiritual assistance—occupying a cause and effect relationship to the former. Since this care is provided by the nurse, it is imperative that only the highest type of nurse be employed. The mental side of the nurse's education is covered by the curriculum, which should be supplemented by proper facilities and the right type of faculty. Physical education is promoted

resents all the hospitals and I believe that the American College of Surgeons should assume it

#### HERNIA OPERATIONS AS AN INDEX OF HOSPITAL INFECTIONS

CHARLES N. COMBS, M.D., Terre Haute, Indiana. Dr. MacEachern not long ago specified the methods that hospitals generally employ in checking the efficiency of their sterilizing processes. This ideal plan covers too much territory to be practical, considering the hospital budget, and there are many operations commonly classified as clean where there are chances for auto-infection. An operation for hernia is primarily free from infection unless introduced by faulty technique. Admitting that elective hernia cases (which debar strangulated and incarcerated ones) are clean to start with, any infection subsequent to operation indicates a break in the aseptic chain. We still use the Diacks, the steam gauge pressure recordings, the constant supervision of the auto-claving, but we use as a control only the elective hernia operations and not the entire surgical output.

During the 2 year period of study we had 150 hernias of this exclusive class or 3 per cent of the total number of operations. Not a single deep infection occurred but there were 17 superficial infections an incidence of 11 per cent. In the first half there were 13 of these infections, or 17 per cent, while in the last half there were only 4, or 5 per cent. To state baldly that we had 11 per cent of infections would be untrue. We have called "superficial infection" the occurrence of a seropurulent discharge on a dressing requiring more than one additional dressing. The average length of hospitalization after operation of the first half of the 150 cases was 14.1 days of the remainder 13.8 days. When hernias run are discharged with dry wounds in 14 days there would seem to be a minimum of infection. Our study demonstrated the advisability of adopting a standardized preparation and the superiority of the point system of after dressings. It showed also that a discriminating scrutiny of the progress of wound healing in selected hernia cases is an authoritative check on surgical asepsis.

#### Discussion

SOUTHWATE LEIGH, M.D., Norfolk, Virginia. I wish to endorse and emphasize the statements of Dr. Combs. The "instrumental" dressing of wounds is important as is also the careful removal and prompt destruction of all septic dressings. However, I am not entirely in accord with the stress he has placed upon auto-infection or infec-

tion from opening the digestive and other tracts. The former is so rare that it may be disregarded safely and the latter can usually be cared for by appropriate antiseptics and an exceedingly careful toilet. I cannot let pass this opportunity to stress the vital importance of strict attention to every detail of surgical cleanliness. Infection is the bane of modern surgery. The weakest point about the large hospital today is the lack of strict operating room control. Operating rooms must be kept clean, ungowned persons must be kept out, and septic discharges caught and promptly destroyed. Frequently gloves are incompletely sterilized. Unless thoroughly steamed, gloves should not be used indiscriminately in clean and dirty cases, and, in addition to the partial heat treatment, they should be soaked, after putting them on the hands in a very strong antiseptic solution such as bichloride 1:250, a weaker solution following. Infection of clean wounds is due to carelessness or ignorance. This is a vital subject and deserves most serious consideration.

#### HOW CAN WE DETERMINE THE EFFICIENCY OF THE SURGICAL MASK?

IRVING J. WALKER, M.D., Boston (see page 266)

#### HOW CAN WE INSURE THE STERILITY OF CATOUT?

FRANK L. MELENEY, M.D., New York (see page 271)

#### PLUMBING IN HOSPITALS AS A SOURCE OF INFECTION—PROPOSED SAFEGUARDS

ARNOLD H. KEGEL, M.D., Chicago. The fact that faulty water supply systems are a means by which water may be polluted after it has been rendered sterile is recognized. The faults in the system most likely to cause pollution of the water are dangerous cross connections. These cross connections permit, at various intervals, water known to be teeming with pathogenic bacteria to contaminate sterile water supplies, thus making it possible to complete the cycle from the source of sepsis to the wound. The cycle producing epidemics of infected wounds in hospitals is readily established by tracing the course of the pathogenic bacteria from an infected wound into an instrument or utensil sterilizer thence by siphonage into the clean water supply, back into the operating room in the supposedly sterile water, and thence into the clean wound. The main points upon which sanitary engineers and hospital consultants should concentrate are the following conditions, which have been found prevalent in the hospitals studied.

presentation of four charts on lantern slides as follows

Chart I statistical analysis of work for month showing among other features mortality rate 2.7 per cent autopsies 33.3 per cent consultations 7.8 per cent somewhat lower than the average of 10 to 15 per cent explained by the fact that consultations were not always recorded

Chart II graph showing percentage of autopsies for each month an average of 43 per cent for the year

Chart III graph showing decreasing percentage of unfinished case records

Chart IV graph showing increasing use of library and bibliographies

In the latter two slides it was readily apparent that with the increasing use of the library the number of unfinished records gradually decreased

The remainder of the hour was spent in the presentation and discussion of 4 cases as follows

Case 1 Presented by D. B. Pond, M.D. Subglenoid dislocation of shoulder with open reduction following failure to reduce by means of manipulation sudden death occurred on ninth day after operation from embolus as revealed by autopsy. This illustrated one type of case which should be discussed at the staff conference—an unexpected death.

Case 2 Presented by Clark A. Boswell, M.D. Acute cerebro-pinal meningitis which made a most satisfactory recovery following serum therapy. This illustrated another type of case to be presented to the staff conference—a case showing a most satisfactory response to treatment.

Case 3 Presented by George W. Green, M.D. Traumatic hemorrhagic pancreatitis with cholecystitis and cholelithiasis death followed shortly after operation. This illustrated a third type of case suitable for presentation at the staff conference for review and analysis of diagnosis and procedure.

Case 4 Presented by George deTarnowsky, M.D. Chronic hemorrhagic ulcerative colitis recovered and patient was shown to medical staff. This illustrated a fourth type of case to bring to the staff conference—one showing intricacies of diagnosis and treatment and the advantages of group analysis.

Discussion was carried on by various members of the staff, including the pathologist and radiologist. The conference demonstrated (1) a proper physical setting (2) a full attendance of staff members (3) starting and ending exactly on time, (4) discussions continuous spontaneous, argumentative, to the point and limited absolutely to actual work of the hospital (5) the proper spirit—group constructive review and analysis of the clinical work, of educational value to all present.

#### THE ACCREDITING OF SURGICAL DEATHS

ERNEST LEROI HUNT, M.D. Worcester. From time to time thoughtful men have urged that we pause to count the cost of surgery in lives and morbidity and scrutinize our products with the

same fair mindedness with which a banker studies his investments or a manufacturer his output. These men include Codman of Boston, Poole of New York, Willis of Richmond, and Bernheim of Baltimore.

Vast betterment in working conditions for the surgeons and increased comfort and security for the patients have been achieved through the influence of the American College of Surgeons through its program for the standardization of hospitals. These things were accomplished by organized effort. Is it not time to turn attention upon the results of our own handwork and apply to them another minimum standard which shall relate to our efficiency as craftsmen in the field of applied surgery to establish a uniform standard method for auditing all surgical deaths and to set up the system necessary for its proper functioning through some central body?

Because of its record of achievement its vast influence upon public opinion the confidence it merits in the wisdom of its leadership, and the fact that its work is our work and not something forced upon us by others the American College of Surgeons is the agent best qualified to determine and promulgate such a standard. The organization to do this work already exists in part and the work proposed is quite in line with the purpose of the College and the existing requirements for Fellows and approved hospitals.

#### Discussion

JOHN DEJ. PEMBERTON, M.D. Rochester, Minnesota. Some hospitals have an ironclad rule which charges to surgery every patient who dies in the hospital after an operation, irrespective of the lapse of time or the cause of death. Naturally, in those instances where death occurs many weeks after the operation and is in no wise the result of the operation or the condition for which the operation was undertaken a strict adherence to the surgical rule is grossly unfair.

Some years ago I wrote to about 15 of the representative hospitals of the country and learned that many of the larger and well managed hospitals had no accepted method of accrediting deaths and also that there was a wide variation in the rules of those that had accepted methods. Since then the American College of Surgeons has made a nation wide survey revealing a most chaotic state of the present method of accrediting deaths and the great need for standardization. A large majority of hospitals earnestly desires some uniform method of recording deaths after operations and I think it is only awaiting leadership. That leadership should come through an agency which rep-

extend the courtesy of their institutions to the qualified independent physicians of their community, and thus enable them to make necessary diagnostic studies in the conduct of periodic health examinations of their patients. This plan would not only provide to physicians an invaluable service but would enable the people of the community to receive the privileges of a diagnostic clinic under the supervision of their own physicians and in the environment of their own homes.

The hospital should furnish an examining room to which any legalized practitioner (who is a member in good standing of the American Medical Association and his county medical society, of the Canadian Medical Association and one of its subsidiary branches, or of similar medical organizations in the South and Central American Republics) may bring a patient for examination. The hospital should furnish to the practitioner such facilities in the way of aids, consultants, laboratory tests, etc., as will insure a comprehensive audit of his patient's condition. The charge for the required laboratory tests should be nominal and the maximum should not exceed actual cost. There should be no charge for the use of the examining room. The physician should render to the patient a bill covering his fee for examination, and where there is a charge for laboratory services he should be responsible to the hospital for its payment.

No hospital should accord these facilities to any individual who is not accompanied by his doctor or who does not carry a letter from his doctor in which certain services are requested. An individual who applies for examination and has no physician should be referred to a duly appointed disinterested committee for advice in the selection of a physician. Each hospital volunteering to establish such facilities will be accredited as conducting a health inventory.

#### Discussion

E. S. GILMORE, LL.D., Chicago. The field of the hospital has extended greatly in the last few years—we now feel we want to do all we can for the community. As evidence of that we have our social service department. This spirit is growing in the hospital and as a development of it we have the health inventory idea. Diagnosis today is totally different from what it was a few years ago. The patient receives service from the laboratory, X-ray, physical therapy and other diagnostic and therapeutic departments. No man, no matter who he may be, can do it all. Then there should be taken into consideration the large number of

friends that could be gained for the hospitals and the amount of good our hospitals could do that they are not now doing.

General discussion followed. Reference was made to the desirability of all hospitals maintaining the good will of the community by doing all possible to promote not only curative but also preventive medicine. In the latter the health inventory is an important factor. Hospitals must take into consideration not only the one-tenth of the people in the community who will be ill enough during the year to require hospital care, but render service to the nine-tenths who are not ill or, if so, are not aware of it. There are two sides to the question—the public and the professional. Physiology, anatomy, and normal functions of the human body are being taught in the early years of medical school and forgotten in the final years. Too frequently the doctor assumes that the individual would not come for examination unless something were very much amiss. Medical men must prepare themselves with renewed knowledge and a changed attitude to meet the requirements of this great movement.

The health inventory can be developed in any hospital. There may be a little room downstairs which can be utilized; an elaborate department is not essential. It was suggested that the American College of Surgeons furnish a uniform blank for the record of examination. This has already been done by the American Medical Association.

The general practitioner is the one who will ultimately make the annual physical examination; the specialist cannot make it. For this reason it was suggested that apparently well persons should be sent to the doctor for examination, allowing the hospital to offer the laboratory, X-ray, or other diagnostic facilities. In New York the State Medical Association has recommended that the people go to their family physicians for examination, except those unable to pay for it, who should go to the hospital.

THE HOSPITAL TRUSTEE'S RESPONSIBILITY IN THE CARE OF THE PATIENT—HOW CAN THE HOSPITAL TRUSTEE KNOW WHEN THE PATIENT IS RECEIVING EFFICIENT HOSPITAL AND MEDICAL SERVICE?

LOUIS J. MCKENNEY, Highland Park, Michigan. A hospital trustee should be willing to give much time, thought and effort to the hospital; he should take an active part in determining its policies and in its actual management. A small board, each member actively interested and having individual responsibility, can procure better care for the patient than a large board not

1 Faulty inlets on water supply connections to hot and cold water sterilizers, permitting leakage of contaminated water into them

2 Drains or blow off pipes on water sterilizers connected to waste pipes through which contamination may be sucked by the vacuum resulting from condensation of steam during cooling

3 Instrument and utensil sterilizers having bottom connections through which infected water may siphon back into the water supply system

4 Steam condensers on sterilizers directly connected to waste pipes which permit siphoning action

5 Therapeutic bathtubs and all other tubs having a bell supply

6 Directly connected bed pan washers, slop sinks, and water closets from which siphonage may take place during stoppage of waste pipes or traps

7 Kitchen and laundry washing machines having submerged inlets

8 Sewer connections for filters condenser coils of refrigerating machines and cooling coils on sterilizers not properly safeguarded

9 Check and waste connections where water supply pipes drain into waste pipes to prevent freezing in exposed locations

10 By passes around sterilizers for the purpose of maintaining a continuous supply of water even though the sterilizer is shut down

11 Cross connections with an impure auxiliary water supply provided for fire protection

12 Suction apparatus connected to water pipes

#### ORGANIZING FOR EMERGENCIES

CHARLES F. NEERGAARD New York In a hospital where centralized control appeared to be based on a general distrust of the personnel—a situation which resulted from several unfortunate experiences—a resident, with the collaboration of several other surgeons and two hospital directors, has worked out some suggestions as to organization. In this hospital it must be remembered, it was not so much the lack of equipment and supplies which was at fault but the lack of availability, whether the need was for a simple laboratory test at night or assistance in the emergency department. It appeared to be more important to prevent theft of supplies than to insure prompt care in emergencies. The suggestions made for the emergency department are as follows:

1 For each emergency call two nurses or a nurse and an orderly, shall report to the depart-

ment to assist the physician. If not needed they may be dismissed. As a further safeguard, a signal system shall be provided to summon help.

2 In order that all equipment and supplies may be located quickly, a complete list indicating the cabinet and shelf where each item is stored, shall be posted in a conspicuous place.

3 The location of apparatus which may be needed but which is kept outside the department shall be stated, also, where the keys are kept.

4 Any appliances with which the average physician may not be familiar shall have clear instructions for their use attached.

5 A properly typed list of donors, if possible from among the personnel of the hospital shall be available for blood transfusions.

#### THE HEALTH INVENTORIUM IN THE STANDARDIZED HOSPITAL

FRANKLIN H. MARTIN, M.D., Chicago Every intelligent individual now realizes the importance of submitting himself to a health audit at least once a year. This procedure has been advocated by many health societies. It has been preached from lay platforms and church pulpits, it has been recommended by authors of health columns, and it has been most earnestly advised by the family doctor. The majority of people, in considering the periodic health examination, naturally turn to this same family doctor for this service. Most people know that clinics and hospital services have been developed that give special consideration to the conduct of periodic health examinations which involve the use of elaborate laboratory facilities and other apparatus requiring trained technical aids for their application. Thousands of highly educated physicians realize that in order to make a comprehensive examination and record certain definite findings they should have access to facilities that are available to their more fortunate brethren through clinics or hospitals. How many practitioners could unaided make a complete physical examination of a patient even though they had at their disposal all the laboratory and other diagnostic facilities? How many distinguished internists, surgeons or other specialists would attempt such an examination without the assistance of a number of expert technicians, and occasionally one or more confreres in other specialties?

The plan called the "health inventorium" virtually provides a means of establishing in every community diagnostic clinics which would be available to all scientific physicians. The plan which the College submitted to the hospitals on its Approved List requested these hospitals to

room, surgeons dressing and locker room, and nurses' dressing and locker room, but only the exceptional layout provides for a quick section room consultation room, dark room, supervisor's office, instrument and equipment room, soiled linen room, and cleaners closets. All service rooms must be accessible and adequate for their purpose. The suite should be constructed and equipped with an eye to asepsis, unnecessary projections and ledges should be omitted. Skylights furnish a cleaning problem. Floors walls and furniture should not be porous, rough or irregular and should be of material and construction to permit of constant cleaning. With mechanical ventilation and heatless lighting units the provision of enormous window and skylight areas for the operating rooms seems to be no longer necessary. Efficient and comparatively inexpensive units of 'shadowless' operating room lights are most approved by the surgeon. One or two spot lights seem to be almost indispensable and a secondary or emergency lighting system is absolutely necessary. A carefully regulated temperature is essential, while mechanical ventilation and electric fans are desirable.

A sufficient supply of instruments should be available for each unit so that one set may be sterilized and set up while the other one is in use. Intravenous and hypodermic injection outfits should be available for instant use. An approved suction apparatus is a standard equipment item. Records must be complete and continuous. The consent slip previous to operation and the anæsthetist's and surgeon's records immediately after operation are important. Skilled nursing and interne services are required. There is no place where co-operation is more essential than in the operating room.

#### Discussion

MAJOR G SEELIG M.D., St. Louis. The most certain way to assure ourselves of the safety of all operating rooms lies in the direction of stressing the fundamentals underlying hospital management and human relationships, rather than in prescribing specific procedures and methods. If we fully realize the facts—that the operating room service of a hospital is the one over which the angel of death most audibly and most constantly flaps his wings—that here, therefore, all regulations must be most thoughtfully formulated and most zealously executed, that such formulation and execution are primarily the duty of the surgical expert and that however weak and human this expert may be in the flesh he always must be willing in spirit to recognize the principle of co-ordination—if we keep these facts constantly

in mind, then the task of creating an operating room service, efficient in every detail, becomes simple beyond words.

#### THE X RAY DEPARTMENT IN HOSPITAL MANAGEMENT

JOHN E. DAUGHERTY, M.D., Brooklyn. A study has recently been completed with regard to the practice in 24 representative hospitals in the organization and administration of the X ray department and from this study the following recommendations are made: (1) the X ray department should be centralized, (2) the director should be relieved of business management, (3) the medical responsibility should be chargeable solely to the director, (4) the facilities of this department should be developed along the lines of diagnosis, therapy, consultation, and teaching, (5) the director should be selected to insure development of the department along the lines indicated, (6) the director should be sufficiently compensated to insure freedom from pecuniary worries and in a manner to insure continuation of professional contacts, and (7) the fees should be arranged to encourage large utilization of this special department, serious consideration being given to a flat fee as a basis for all hospital charges.

#### Discussion

EDWARD S. BLAINE, M.D., Chicago. The X ray department has three responsibilities:

1 To the patient. The department should give every individual requiring its aid a maximum of help.

2 To the patient's physician. If the service rendered is not a maximum one both the patient and the physician are literally short changed.

3 To the hospital. This is reflected in the reputation built up for thorough work in the care of the sick.

The department head should have for his major function the accurate interpretation of X ray findings. All management, in so far as possible, should be left to the executive office of the hospital.

Whether or not a hospital can afford to pay for the full earning power of a competent roentgenologist depends upon the size of the hospital and its potential income. It is practical and economically proper to have several hospitals in a neighborhood buy the services of one competent roentgenologist so that his total income will be satisfactory to him. The income from the X ray department might roughly be divided into three parts—one third going to the roentgenologist for his work, one third to the hospital, and



active as a whole. Responsibility with regard to housekeeping, finance, purchasing, nurses' training, school, and maintenance are assumed by individual members of the board, co-operating with members of the hospital staff to whom these duties are assigned. Final authority on major questions is not given to the individual trustee but is vested in the entire board, which generally carries out the recommendations of the individual trustee. The board of trustees should see that the superintendent employed by them is one of ability and high standing in his profession so that the trustees can with confidence accept suggestions from him in establishing the policies of the hospital. Policies once adopted should be enforced by the superintendent through his personnel. Trustees should not interfere with the personnel except through the superintendent's office. The work of the hospital should be judged by (1) its reputation in the community (established by satisfied or dissatisfied patients) and (2) an analysis of the case histories by an executive committee of the staff. The adoption of the standardization program of the American College of Surgeons will serve as a great help to any board of trustees in increasing the efficiency of the service. The board should in return demand from every member of the staff the most sincere effort and co-operation.

#### Discussion

JOHN D. SPELMAN, M.D. Pittsburgh. The solution of this problem can be found in the form of the terse dictum "Know thy hospital." The first and most important factor is the general hospital policy, as reflected by the ideas and ideals of its motivation, then the application and motivation by the directing head to whom is entrusted the duty of carrying out the hospital's policy. To these should be added the degree of resource that is placed at the disposal of the directing head in terms of personnel competent to contribute a creative performance and, last but not least, the resources of the medical staff and the degree of organization accomplished to insure medical teamwork.

If the trustee wishes to think of his institution in terms more idealistic than those applicable to a medical boarding house, he must assure himself that his hospital adequately carries out four cardinal functions: (1) that it has and is utilizing the most advanced armamentaria for treatment and diagnosis, (2) that the hospital's experience with disease is being properly recorded, the usefulness of correct scientific data proved, and incorrect data discarded (this constitutes the

hospital's contribution to the sum total of medical knowledge), (3) that the facilities and experience with disease are being utilized in the training and developing of hospital personnel, and (4) that the hospital is contributing its fair share to preventive medicine.

NEWTON E. DAVIS, Chicago. The board of trustees is legally responsible for the patients in the hospital, the superintendent is not. The superintendent is simply an officer of the board of trustees to see that the latter act in conformity with the civil laws, the national and state laws, to see that the patient is given a fair deal, good diagnosis, and good treatment. The trustee will never know when the patient is receiving efficient hospital and medical service until every state in the Union is made responsible for the legal practice of surgeons in hospitals. The time is coming when the board of trustees will require assistance from the state to make it impossible for a man who does not know the technique of surgery to practice on any patient in any hospital anywhere, as well as in his office. The trustees do have responsibilities. They must carry on in a way that will create confidence not alone in the mind of the individual but in the minds of the community and of all who have anything to do with the practice of modern surgery and hospitals.

In the general discussion which followed emphasis was laid on four very important factors bearing on the subject: (1) the governing body or board of trustees should select a hospital executive, competent to take charge of all departments who should have adequate administrative and technical assistance efficiently to carry out the policies of the institution, (2) the individual members of the governing body or board should not concern themselves with the details of management of the hospital, (3) the governing body or board should have some comprehension in the means of knowing when the patient is receiving efficient hospital and medical service, (4) the general consensus of opinion and the decisions of the Supreme Courts of the United States and Canada hold the governing body or board of trustees legally responsible unless it can be clearly shown that it has exercised due diligence and care in its selection of agents and employees.

#### WHAT FACTORS ENTER INTO AN EFFICIENT OPERATING ROOM SERVICE?

A. C. GALBRAITH, Toronto. The operative suite is generally located on the upper floor in order to secure the quietest, brightest and most cleanly location available. The average suite includes anæsthetic rooms, sterilizing room, work

7 Hospitals have organized staffs which are ever ready to consider the financial condition of the patient and reduce their charges accordingly.

W P MORRILL, M D, Portland, Maine The high cost of getting well would be reduced if (1) surgeons, instead of all demanding the same operating hours, would spread their operating hours over the forenoon, thus permitting a 50 per cent reduction in the number of operating rooms and the saving of thousands of dollars in construction, equipment, and personnel, (2) surgeons would depend less upon mechanical aids, reducing the demands upon the hospital laboratories, (3) surgeons who are familiar with the financial status of their patients would take it into consideration in making arrangements for them to enter encouraging them to be content with less expensive quarters, (4) surgeons would keep the records they are pledged to keep, thus saving the hospitals large amounts of money in expensive dictaphone equipment, specially trained stenographers, and follow up systems to secure the completion of records and (5) surgeons would cease to order special nurses for patients who want only a glorified lady's maid. Verily, it is not the high cost of living but the cost of high living that confronts us.

ASA S BACON, Chicago Since the World War the value of money has decreased and hospitals like other institutions, have to pay increased salaries to employees and higher prices for all commodities. Following is a comparison of the cost of hospitalization in 1904 and 1905 with that in 1928, considering in each instance similar cases which is based on data from the ledgers of the Presbyterian Hospital, Chicago

Operation	Year	Rate per diem	No of days in hospital	Total cost including extras
Appendectomy	1903	\$1 75	22	\$38 50
	1928	4 00	10	54 00
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	1928	7 00	20	164 00
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	1928	5 00	13	72 75
Prostatectomy	1904	5 25	204	255 00
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Operating room laboratory X-ray special nurse etc

It is interesting to note that obstetrical patients in 1904 stayed on the average, 21 days, whereas in 1928 the average stay was 10 to 12 days. In 1904 and 1905, no extras, such as operating room charges, X-ray pictures, laboratory tests, electrocardiograph tests, metabolism tests and other tests which aid the physician in making quick diagnoses, were included in the patients' accounts, while in 1928 each of the patients had one or more of these charges to pay. The rate for the rooms

and ward beds in 1928 was rather more than double the rate in 1904. However, the advantage in 1928 of the great cut—more than 100 per cent—in the length of stay, allowing the patient to resume his occupation much sooner, is very evident.

#### THE ROLE OF THE RECORD LIBRARIAN IN MAINTAINING AN EFFICIENT RECORD SYSTEM

FLORENCE G BABCOCK, Ann Arbor Expansion and vision must be the watchwords of the hospital record librarian, for as an educational assistant she is an active factor. There is the interne to be trained in history taking or the routine of writing records the importance of which cannot be overestimated. The record librarian must be ever watchful to see that the proper information goes into the records. Their contents should be held in the strictest confidence by everyone who has access to them.

The record librarian also has another role, which relates to finances, if she has clinic clerks under her supervision whose responsibility it is to see that pay cases reach the proper desk for the payment of fees. She must be familiar with the policies and rulings of the hospital for she is the principal source of information concerning them. She must ever be on the alert to improve her department. A person of pleasing, happy personality is much to be desired. She must have the unflinching support of her record committee for in them is the bulwark of her strength. However, paradoxical as it may seem, she must be a power sufficient unto herself, for many times she will be called upon to muster forth all of her reserve forces.

#### Discussion

C W MURGER, M D, Valhalla, New York Great emphasis should be placed on the librarian's work with the internes. The record librarian should assume the full responsibility that goes with the position. At the Grasslands Hospital small mimeographed slips are attached to deficient records, each with specific headings showing what is incomplete and the part of the chart in which it is—quite a time saving procedure for the doctor. To promote record work in hospitals printed professional standing orders should be issued containing very explicit directions regarding records. The record librarian should attend staff meetings and conferences, all medical meetings, and internes' meetings.

#### MAINTAINING EFFICIENT CASE RECORDS IN AN OPEN HOSPITAL

MARJORIE BOULTON, St Louis The Jewish Hospital of St Louis has adopted the following

one third to be divided among the cost of materials, the salaries of others than the director, and a depreciation fund. No department should operate at a loss. From an economic basis it might be well if, in X-ray work, we had one charge for examinations limited to a single part, and another fee for complicated examinations.

WHAT IS BEING DONE TO ASSIST THE PERSON OF MODERATE MEANS IN SECURING ADEQUATE AND EFFICIENT HOSPITAL AND MEDICAL SERVICE?

MICHAEL DAVIS, PH D., Chicago. The practical things the hospital can do for the patient of moderate means have been divided into two kinds: (1) changes in the physical plan, and (2) administrative adjustments. Of 467 hospitals that reported in a recent survey as to the proportion of single rooms, private rooms, semi-private rooms (with 2, 3, or 4 patients in them), and small wards (of less than 10 beds) as distinguished from large wards, this rather interesting situation was found. There were altogether about 100,000 beds. Outside the large wards these hospitals had nearly 60,000 beds in wards of less than 10 beds, in small rooms, and in single rooms. In the single rooms there were 27,000 beds; in semi-private rooms, 16,500 beds; and in wards of less than 10 beds, 17,000 beds. The largest single group of accommodations available to persons of moderate means outside the large ward is the single room—the highest priced type of accommodation.

Some facts were gathered from architects who are specialists in hospital designing. In 1903 the hospitals designed by some dozen architects had 28 per cent of their beds in large wards. A larger number of architects reported an average for 1918 of only 7 per cent of the beds in large wards. In other words, the designing of new hospitals exhibited a very marked trend away from the large wards in the direction of the single room, the semi-private room and the small ward. The trend in the direction of smaller wards and single rooms is not in the direction of reducing hospital costs although it clearly meets the demand of the public as to luxury in hospital accommodation.

From the point of view of administration the changes are: (1) the development of the admission system in such a way as to adjust the rate to the patient's ability to pay, and (2) adoption of flat rates for maternity and certain other cases. Only a small proportion of the hospitals replying to the questionnaire reported any particularly significant developments. They all manifested keen interest in the subject, they are wide awake but find it difficult to do much about it.

It seems to me that this study shows us that the public must not be misled regarding the possibilities of taking a big slice off the cost of medical service. The public after all, demands service. To get that service it must be paid for. Dealing with the patient's bill through prevention and the distribution of the financial burden by some scheme of installments or insurance offers the most hopeful outlook for a solution of this problem. Surely it is desirable to proceed along the lines of adjustment of physical planning and adjustment of rates. Surely it is desirable to obtain more data, since one of the facts made obvious is the lack of real information on hospital costs, particularly for each special type of accommodation. Adverse criticism by the public is due to its ignorance of the facts. The hospital furthermore, must deal with the existing financial structure and not attempt to impose a method for the payment of hospital and doctors' bills by demanding a sudden payment in an emergency situation in a community that is already accustomed to distributing the burden over a period of time.

#### DISCUSSION

HERMAN L. FRITSCHEL, Milwaukee. A few years ago the Bureau of Labor Statistics of the United States Government made a study among 12,000 wage earners, families and found that the average medical expense was a little over \$80 per family per year. I have made a study of the first 100 cases admitted to the Milwaukee Hospital in 1929. The average cost of hospitalization per patient during his time of sickness was \$44.64 in the wards, \$83.80 in private rooms, and \$84 in the maternity department. Hospitals are providing for those of moderate means as follows:

1. Nearly every hospital has a number of beds for which it charges less than per capita cost.

2. Many hospitals have clinics and dispensaries where assistance is rendered gratuitously or at a nominal fee.

3. Hospitals maintain social service departments rendering services free of charge or at small expense.

4. Hospitals have endowments enabling them to furnish service at a more moderate price than would be possible if the actual cost had to be charged.

5. Hospitals are built by money raised for their erection and equipment and the capital invested is at the service of those of moderate means without any interest for investment being charged.

6. Hospitals as a rule allow patients of moderate means to pay their hospital bills in installments.

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method of maintaining efficient case records. Upon admission of the patient, the admitting officer records the following data: patient's name and address, the hour and date of admission, age, marital state, nationality, and occupation of the patient, name and address of his nearest relative, and name of attending physician. Also any records of previous admittances are made a part of the patient's new record. The resident physician is then notified. After a preliminary examination he assigns the patient to the service to which he belongs, calls the attending physician, receives orders, and transfers them to the interne in charge of the service. The interne notes the present condition of the patient and writes orders for the nurses.

A complete history, with physical and routine laboratory examinations must be recorded within 24 hours after patient's admission. Operative and anæsthetic notes are recorded within 24 hours after operation. Postoperative notes must be written daily on all surgical cases until the patient is considered convalescent and out of danger; then progress notes are written less frequently. No history is filed away without a final note from the attending physician as to his findings and diagnosis. Upon discharge a brief resume is made by the interne, stating the patient's condition and his diagnosis. Charts for each service are inspected 3 times a week by the record librarian, who makes a notation of any missing data and calls it to the attention of the resident physician. After the patient is discharged and the chart is sent to the record room it is inspected for any possible missing data. Through the medium of the bulletin board incomplete charts are called to the attention of the doctor responsible.

Record meetings of the medical staff are held weekly at which time the records are reviewed and discussed. When the record is completed the name card is attached to the history, bearing the hour and date of discharge, condition upon discharge, and final diagnosis. The record librarian co-operates with the physicians in their research work by collecting adequate material, compiling it in a convenient form and placing it in the regulation history binder. Out of town physicians or those not connected with the regular hospital staff, who refer patients to the hospital wards for treatment are mailed a statement of the staff physician's findings, diagnosis, and treatment instituted with suggestions as to continuance.

#### Discussion

DONALD C. SMELZER, M.D., St. Paul. A few years ago it was a known fact that the open staff

hospital had poorer records than the closed staff hospital which is easily understood on analyzing the situation. The importance of obtaining complete histories is inestimable, and if the hospital starts its internes right and keeps close check on the staff—whether open or closed—there should be no difficulty in having first class records in any hospital. The record room should be located where closest contact with the medical staff will be afforded. Hospitals depend to a great extent on the interne for case records. Medical schools should more adequately educate internes along the lines of taking good histories.

#### THE VALUE OF ACCURATE RECORDS FOR THE STUDY OF CANCER

MAUD SLYE PH.D., Chicago. The value of accurate records in the study of cancer cannot be overestimated. Records from which can be obtained the history of heredity will be of untold value to the research worker in evaluating experimental data. All research is started with a fairly limited specific goal, but probably no problem however single was ever thoroughly studied, whose attempted solution did not disclose numberless allied questions, since relations in nature are intricate and universal. Thus the solution of the most closely limited problem opens the way to new solutions and new light. The whole accumulation of science is built upon this fact. It would not be possible, I think, to take complete accurate records for a long period of time upon any matter whatever without converting them into science and collecting returns unsuspected when the records were started.

Records have been disesteemed, the taking of them has been considered a red tape bore and has been turned over to somebody—perhaps to the least important person concerned in the case. What we have wanted always is to cure, and the history of medicine is mainly a history of therapy and of therapeutic surgical procedures. We must see that we can never really cure until the causative factors are known. Then we can hope not only to cure but also to prevent. The way of finding the causative factors through records is slow, painstaking, monotonous and fatiguing, requiring an intelligence never asleep, however irksome its occupation. Records must seek to penetrate and find the crucial points in the history of every case and no record can ever report a past history as negative. It will seek to find the elusive positive. When hundreds of repetitions of these elusive positives stand out in the study of any given group of neoplasms they will cease to be elusive and must declare them-

selves. If we can make our records sufficiently penetrating if we will be patient, and consistently scientific in taking them, the external provocative factors in each type of neoplastic growth may be found. They will never be found from negative histories. They cannot, in many cases, be found from laboratory animals whose habits of living are unlike those of humanity and exclude many of the possible provocative factors commonly present in human living. It is time we accepted these penetrating human heredity records so that the part which heredity may play in the causation of human cancers need no longer be a matter of opinion but may be scientifically established or scientifically disestablished.

#### Discussion

BOWMAN C. CROWELL, M.D., Chicago. With out proper histories knowledge of cancer will not advance. At present complete histories on cancer do not exist, that is the reason we are not making more progress in our knowledge of cancer. Aside from the research work being done in various laboratories the establishing of the Committee on the Archives of Malignant Diseases by the American College of Surgeons is a means by which we hope that records throughout the country may be improved. As an organization we seek the co-operation of record librarians, visiting nurses and social workers, particularly the latter two who follow up the patient after treatment. The follow up is most important in these cases and as you know the record has just begun when the patient leaves the hospital. The fact that the patient has been in the hospital, has had a thorough examination with all this data accurately compiled in an acceptable record qualifies the case for being recorded in our archives. Any hospital contributing to this work in the manner above described will be rendering a real service to science which ultimately of course, must redound to the benefit of humanity.

#### THE CORRELATION OF THE RECORD DEPARTMENT AND MEDICAL LIBRARY IN THE HOSPITAL

STELLA FORD WALKER, Chicago. A combined record department and medical library with proper provision for research assistance results in more complete records and more interesting and profitable staff meetings. Series of cases in the hospital or a single unusual case may be made the subject of study associated with a review of the literature in point. An active library will be called on continually in connection with the work in the hospital furnishing information to the laboratory on occasion or to the doctor in the diagnosis or

treatment of unusual cases, encouraging the study of internes, and serving in many other practical ways every day. Because of this close association of the work there is an advantage in having the library and record room combined or closely associated. The medical librarian and record librarian training should be associated. So much of the training is common to both and it is an advantage to either group to know the field and the possibilities in the work of the other group. The College Library affords a training center for such librarians, where intensive training in the fundamentals in the College Library and Research Department is offered.

#### Discussion

MARGUERITE SIMMONS, Chicago, and MAURINE WILSON, Chicago. About a year and a half ago the Ravenswood Hospital combined its library and record departments. The bi-weekly staff conferences are held in the library record room, and at these conferences many records are completed and requests for library service received. It has been noted that as the requests for material in the medical library have increased in number, case records have been increasingly used for study, thus decreasing the number of incomplete charts reaching the record room. These hospital records are readily available, facilitating consultations and the compilation of statistics on groups of cases.

DAVID C. HILTON, M.D., Lincoln, Nebraska. The surgical section of the Bryan Memorial Hospital is responsible for one staff program annually. The basis is a study of a definite surgical problem based on compilation and analysis of case records on file in the hospital. This study is arranged as a monograph, with a convenient index and list of references for practical use by members of the staff to aid them in their clinical problems and to lay a foundation for future studies of the same problem. These studies are mimeographed or printed in sufficient quantity for general distribution to the staff. The first study was on toxic goiter in perhaps 10 years this same subject will be reviewed from the hospital records. Arrangement of the program, which is the same in all studies is as follows: (1) the title, (2) an index, (3) a digest in outline of the surgical problem, with a list of references, (4) the kernel of the report and (5) appendices. The greatest problem before the compiler is to originate this form by which he tabulates all case records. This year we are getting up a study of records on appendicitis so that we will all be together and be studying the same thing and talking the same language in the

department of general surgery and the department of pathology. This type of procedure furnishes many advantages: an interesting meeting for the entire staff; a valuable contribution to clinical surgery in the hospital; a monograph on the subject for each of the staff members; a demonstration of the value of complete and well written records; a demonstration in detail of points wherein the records on a given series of cases are incomplete, unreliable or worthless, and of the seriousness of such delinquencies to the clinical files of the institution from a scientific standpoint; the establishment of an adequate plan of scientific research in certain clinical problems from the records; the development of useful classifications; the constructive criticism of clinical forms; the proposal of minimum standard entries on record forms essential to proper compilation of scientific data in a given clinical problem; proof of the scientific value of good records; and inculcation by example of the scientific spirit in making and studying clinical records.

#### THE NURSE'S CONTRIBUTION TO THE MEDICAL RECORD

T. R. POYTOV, M.D., Chicago. Emphasis is placed on recording of important symptoms as observed by the attending nurses. There are two systems in vogue: (1) to have the nurse who observes symptoms chart her observations; (2) to have certain designated nurses do all charting. In the former arrangement the charts are not so neat, not so legible, but contain more information. The disadvantage is that notations will be made by junior nurses not yet trained to distinguish important from trivial symptoms. In the latter arrangement, whereas the charts are neater, no particular person is responsible for observations and only those reported can be charted. A combination of the two systems might solve this problem. Temperature, pulse and respiration observations could be made on groups of patients recorded on a group sheet, then transferred to the individual sheet. One nurse could be held responsible for this, but observations of symptoms should be recorded by the nurse who observes.

Observation forms should be uniform with the same type of observation always recorded in the same place, in order to secure ease of reference. The graphic chart and the nurse's notes are the two forms used; the former having proved the better from experience. The doctor's orders also should be written. The best system is that in which the doctor writes his orders in a separate duplicating order book from which the nurse

transcribes them to her "orders for treatment" sheet. Cancellations are also written in the same book.

#### Discussion

LAURA R. LOGAN, B.A., R.N., Chicago. The nurse's record is of vital importance. It should be a permanent record. Two types of observations should be charted—both mental and physical reactions; the latter involving a great many items—thus accomplishing the objectives of charting among which accuracy is one of the most essential. The purposes of charting are: (1) to give the doctor accurate, detailed information of the hourly, daily, or weekly progress of his patient portraying symptoms which indicate any change in the patient's condition; (2) to train student nurses in accurate observation of significant symptoms and the proper recording of same; (3) to aid the physician in following the course of the disease or in arriving at conclusions as to treatment; and (4) to give an absolutely honest record of the patient's entire stay in the hospital.

The head nurse of the ward must be responsible for the quality of charting. Accuracy requires her constantly to check and recheck the charts by her own observation of the patient as well as by the doctor's order book. To point out to each student nurse any error she may have made, and to comment on the accuracy of the observations of the student nurse.

A. L. LOCKWOOD, M.D., Toronto. I am particularly interested in the question of records from the professional man's point of view. I have been impressed for some time with the great necessity of attempting to boil down into figures all the facts that we as medical men want. It has been stated that figures can be so compiled that they will not mean anything. On the other hand, I do not believe any of our real knowledge amounts to anything if it is not substantiated by cold facts and figures. In the Lockwood Clinic we have endeavored for a period of 7 years to boil down all the data in regard to the patients that come under our care, no matter whether such data are of an academic nature or of importance from the point of view of the diagnosis, the method of treatment—medical, surgical or whatever it may be—and the after results. We try to boil our data down to a matter of figures, then chart it graphically, placing it where all the members of the staff see it daily. A great deal of the work of reducing data to figures and graphic charts is done by the girls who work in the library and in a combined library and record department, one girl becoming an authority on medical literature.

relative to the various classes of records, and the other a real authority on records. Accuracy must be emphasized above all else.

The general discussion was conducted by **EDITH M. ROBBINS**, Boston, and the following problems were presented:

*Making annual reports more interesting.* The Cushing Christian report of the Peter Bent Brigham Hospital, Boston, was described in detail. This report presents the material in a most readable and interesting manner, reviewing the past and looking forward to the future. Statistical data follows the Massachusetts General Hospital classification of diseases.

*Maintaining the privacy of case records kept in the wards.* Case records should be kept in the ward while the patient is in the hospital but not for inspection by others than doctors, internes, or nurses concerned with the diagnosis, treatment, and general care of the patient. The physical arrangement and management of the ward or unit should provide this privacy. It was also stated that occasionally there might be information of a nature so extraordinarily confidential as to warrant keeping it in the record room all the time.

*Printed standing orders.* It was deemed advisable to standardize routine procedures in the hospital as far as possible and have these printed for distribution to facilitate the work of the attending doctors, internes, and nurses.

*Methods of securing histories.* **GRACE W. MYERS**, Boston, reported that for the last few years at the Massachusetts General Hospital medical students from Harvard Medical School and other nearby medical schools have acted as assistants in taking records, thus early learning the proper method of writing histories. According to **R. C. BUECKI**, M.D., Madison, a similar system is carried out at the Wisconsin State General Hospital, Madison. The history and physical examination made by the student becomes a permanent record which both the interne and resident must check over and correct. In this way the student does better work than when the histories were destroyed after being written. **ROBERT JOLLY**, Houston, reported that owing to lack of internes he used a graduate nurse to secure histories and the attending doctor added the physical findings. A few hospitals adopt this procedure but the general consensus of opinion was that the attending doctor himself should write the record or if assisted by internes, nurses or others, he should be responsible for its accuracy and completeness.

*Records in the study of cancer.* **GRACE W. MYERS**, Boston, stated that she saw no reason why a well trained record librarian who has been

sufficiently instructed in the work and knows what a perfect record is should not be capable of securing accurate histories of cancer cases. The securing of adequate records of cancer cases presupposes more complete data than for the ordinary record, with a far reaching investigation into heredity and negative findings.

*Nurses' notes.* **MURIEL E. ANSCOMBE**, R.N., St. Louis, stated that nurses should be carefully taught to observe symptoms and intelligently record them. The doctor's notes should be his own observations which naturally, are written in more technical language than the nurses' reports. In the opinion of **Mrs. G. HARRIES**, Chicago, doctors and internes should verify the nurses' notations on charts, then make their progress notes. **ADDIE ELDREDGE**, R.N., Madison, expressed the viewpoint that the nurse should make no attempt to diagnose, nor should her observations take the place of the doctor's observations. But as the doctor and the interne see the patient only occasionally they can ascertain from the nurse's record if what they observe at the moment is true for the rest of the 24 hours. We know quite well that a patient may show some symptoms when the doctor is not there that he will never see.

#### STANDARDIZATION OF SURGICAL DRESSINGS AND MATERIALS

**FREDERIC H. SLAYTON**, M.D., Chicago. When the American College of Surgeons undertook the standardization of surgical dressings, many hospitals submitted, upon request, statistical data and samples of various sponges and dressings totaling over 4,000. A careful analysis of these was made as to type, dimensions, and general structure, and the economic aspect of production of these dressings was also considered. As a result of the survey to which extensive care was given, we may make the following general provisional classification: (1) dressings for sponging or wiping, (2) dressings for walling off, (3) sterile gauze to cover incisions or wounds, (4) dressings to absorb drainage after operation, (5) gauze drains and tampons, (6) bandages, (7) binders, and (8) dressings for specialized purposes. Types under these headings have been selected and as soon as the production engineers of the several co-operating firms give their report the final selections will be published in a manual together with information pertaining to these dressings as used in hospitals.

It is quite evident from an analysis of the data collected during this survey that the usual method today of providing surgical dressings in the hospitals lacks uniformity, both as to manner of



preparation and type of product demanded and usually furnished. It is reasonable to assume that the cost under the present method may be excessive and, while not a major factor in hospital expense, it is nevertheless worthy of a comprehensive analysis.

### Discussion

**HUGH SCOTT, M D**, Hines Illinois. In addition to the standards of the College we at the Veterans Hospital, have our own standards and equipment specifications furnished through an organization in Washington working in conjunction with the Bureau of Standards. All the gauze bandages and adhesive plaster we use must meet the requirements of the Federal Specification Board. This means greater economy and efficiency in the administration of the hospital.

### THE VALUE AND IMPORTANCE OF THE HOSPITAL OUT PATIENT DEPARTMENT

**IRVING S. CUTTER, M D**, Chicago. The hospital should be the first thought in illness rather than a last resort, hospitals should therefore be so organized and equipped as to give the maximum service to ambulatory as well as to bed patients. The out patient clinic may be in a separate building but is probably more efficient as an integral part of the hospital building. There should be physicians' offices, examining rooms and laboratories for routine work with close co-operation between the general hospital laboratories all of which makes for more economical and efficient medical service. The out patient clinic is applicable to pay, part pay, and wholly free cases as may be determined by the location of the hospital, its obligations to the public and the endowment provided for free care—ambulatory or bed. If free or part pay service is contemplated social service personnel is required.

### Discussion

**HERMAN SMITH, M D**, Chicago. The out patient department has an important place to fill, particularly in the larger hospital. It deserves as much attention as the in patient department from the standpoints of organization and administration. This presupposes competent well organized lay and professional staffs. While the primary function of the out patient department must be the care of the ambulatory patient the department must not overlook its responsibility for the education of doctors, internes and nurses for the prevention of disease and for the promotion of clinical research. If the out patient de-

partment falls short of this responsibility it is not fulfilling its real purpose.

**LEWIS A. SEXTON, M D**, Hartford. There are a few additional benefits to be derived from an out patient department. It will serve the general hospital in training future members for the staff, it acts as a clearing house, and a very good one at that preventing many very poor diagnoses, it aids in prognosis for a long continued observation of thousands of cases can be better than any other one thing, aid a physician in prognosis. It relieves the hospital wards of about 15 to 20 per cent of the cases that would otherwise be in the hospital, and is much less expensive than to have them in a hospital ward.

### WHAT CONSTITUTES AN EFFICIENT CLINICAL LABORATORY SERVICE FOR A HOSPITAL?

**FRANK W. HARTMAN, M D**, Detroit. The laboratory service will be adequate if it is under the supervision of the right type of physician-director, because such a director will not tolerate inadequate working facilities. Standardization programs should emphasize the laboratory personnel above and beyond, but not to the exclusion of, building and equipment. The laboratory and the pathologist should be rated on their capacity and willingness to assist in diagnosis, treatment, education and investigation.

Experience has shown that in the larger hospital the work can be divided advantageously into morphological pathology, bacteriology, basal metabolism, chemistry, clinical microscopy, and serology. For the best results the physician director should take a principal part in the morphological pathology. In the larger institutions the pathologist must do his utmost in supplying the present urgent need for well trained physician directors and laboratory assistants. The ideal situation is that in which surgical pathology is handled by the department of pathology and the surgical staff meets with the pathological staff to review the material.

In the hospital laboratory the course of instruction should include approximately, 4 months in bacteriology, 4 months in physiological chemistry, 3 months in serology, 3 months in clinical microscopy, 2 months in basal metabolism and 2 months in tissue technique.

### Discussion

**OLIVER W. LOHR, M D**, Saginaw, Michigan. The Central Laboratory of Saginaw which serves 3 hospitals comprising 403 beds was established 8 years ago. Nurse technicians were trained in making the usual routine examinations.

—urinalyses blood counts collections of blood for Wassermann tests, blood groupings, and chemistry—and making smears for gonococcus and malaria, other laboratory procedures being performed as indicated by the attending physician. This routine service is compulsory if the patient remains over 72 hours for which a charge of five dollars is made. Charity cases, however, receive laboratory work in the routine manner without charge. When indicated these services are rendered: examination of spinal fluids, of spurs, of pleural, ascitic, and abscess fluids, and of faeces, gastric analysis, cultures, and inoculations. An extra charge is made for other examinations than the above. All positive reports are sent to the physician immediately, the rest within 24 hours. The laboratory has modern equipment and offers educational facilities to all interested. The quota of autopsies has been maintained, and demonstrations of the latter are given at all staff meetings by the pathologist.

P F MORSE, M D, Detroit, stated that it is absolutely impossible for the small hospital to have a full time pathologist because there are not enough patients to keep him interested even if the hospital could afford to engage him. Very often the political situation enters into the normal solution of combining several moderate sized hospitals and employing one pathologist. Harper Hospital, Detroit, is endeavoring to assist the small hospitals in this respect by providing personnel to do their autopsies and other work. This will assist them in meeting the requirements.

J J MOORE, M D, Chicago, stated that no hospital of 100 beds can engage a competent pathologist unless it is an endowed or a municipal institution. Some hospitals state that they have a full time pathologist when this is true in name only and actually they have none at all. This matter should be checked up through more complete inspections.

#### WHAT CONSTITUTES AN EFFICIENT ANÆSTHESIA SERVICE FOR A HOSPITAL?

WESLEY BOURNE, M D, C M M Sc, Montreal. To have an efficient anæsthetic department it is well to have a staff, sufficient for the number of operating rooms, of expert anæsthetists, preferably graduates of medical schools who have served some time in internship. The senior anæsthetist should be accorded a place on the medical board with rights equal to the other members. Briefly, the chief anæsthetist's responsibilities are: (1) the care of anæsthetic appliances and requisitions for new apparatus; (2) the keeping of records, (3) the allocation of

work, (4) the teaching of housemen and students, (5) the conduct of frequent colloquia, (6) the encouragement of scientific investigation, and (7) the maintenance of harmonious co operation with the surgical staff.

#### DISCUSSION

ISABELLA HERR, M D, Chicago. Emphasis must be placed on the importance of medical graduates as anæsthetists and the need of organization of an anæsthetic staff. It is my belief that the patient should be responsible for the anæsthetist's fee, receiving the bill directly from him.

JOHN LUNDY, M D, Rochester. In this country it does not seem practical to have a staff of medical men as anæsthetists. In some institutions the anæsthetist may be a dentist, in others the anæsthetic may be administered by nurses, sisters, or others. Dr. Kris of Boston has very well exemplified the value an anæsthetist of competent judgment may be to his associates. The situation in the Walter Reed Hospital in Washington, D C, where Dr. Gallaher is in charge of anæsthesia, illustrates the shock treatment that can be taken care of by that group constituting the department of anæsthesia. Medical men should make as great use of the department of anæsthesia as the surgeon and should furnish certain lectures on the subject to nurses. The department should assume the responsibility of indexing its records under the direction of the superintendent of this department. Literature on anæsthesia should be read and abstracted by members of the board of anæsthesia and made available to the student nurses.

An anæsthesia record blank should record: (1) preliminary treatment, (2) time of anæsthesia and operation, (3) blood pressure—graphically or otherwise, (4) condition of patient, (5) effects of anæsthetic, of medication, of blood transfusion, and of sodium chloride, gum acacia, or glucose solution, (6) extent of operation, (7) number and type of drains, and (8) list of operating personnel. During operation the color of the skin and blood, humidity of the skin, and relative temperature should be recorded. Considerable space should be given to "remarks" which serve one of the most useful purposes of any part of the record.

#### A PLAN FOR INCREASING THE NUMBER OF AUTOPSIES

MAURICE DUBIN, Philadelphia. At the Mount Sinai Hospital in Philadelphia a campaign was organized in September, 1927, to raise the percentage of autopsies which was then practically nil. Within 4 months this was increased to almost 50 per cent by adoption of the following plan:

preparation and type of product demanded and usually furnished. It is reasonable to assume that the cost under the present method may be excessive and, while not a major factor in hospital expense, it is nevertheless worthy of a comprehensive analysis.

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partment falls short of this responsibility it is not fulfilling its real purpose.

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Experience has shown that in the larger hospital the work can be divided advantageously into morphological pathology, bacteriology, basal metabolism, chemistry, clinical microscopy, and serology. For the best results the physician-director should take a principal part in the morphological pathology. In the larger institutions the pathologist must do his utmost in supplying the present urgent need for well trained physician-directors and laboratory assistants. The ideal situation is that in which surgical pathology is handled by the department of pathology and the surgical staff meets with the pathological staff to review the material.

In the hospital laboratory the course of instruction should include approximately 4 months in bacteriology, 4 months in physiological chemistry, 3 months in serology, 3 months in clinical microscopy, 1 month in basal metabolism, and 2 months in tissue technique.

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meets with the approval and co-operation of the medical staff. Each tonsil case should have a complete history. It is not necessary for the attending doctor to sign each page of the history provided there is a covering statement somewhat as follows: "This is to certify that the undersigned has carefully reviewed the data and findings in this report and to the best of his knowledge believes them to be accurate and complete." A copy of the doctor's office record should be acceptable if complete.

*Internes.* Many hospitals have great difficulty in securing and keeping internes. There are numerous instances where internes have broken their contracts. The cause of this condition was ascribed to lack of interest or organization on the part of the hospital management or medical staff or perhaps both. The hospital management and the medical staff must jointly assume responsibility for seeing that the interne receives a carefully supervised, worth while medical education and experience while in the hospital. Each member of the medical staff should constitute himself a teacher for the interne in his daily contact. Group and individual interest and responsibility for the welfare of the interne are essential.

*'Open' versus 'closed' hospitals.* The 'closed' hospital has the advantage of a carefully selected medical staff affording better control over the professional work and the scientific policies. It permits more uniformity of action and standardization of procedures. It, however, does not afford the general profession the opportunity to keep abreast with the progress of medical science. The 'open' hospital can be so regulated as to be under adequate control, provided that the medical staff is properly organized, that it lays down definite policies regulating the professional work, and that these policies are approved by the governing body or board of trustees and carried out by the management of the hospital with the support of the medical staff. Better control can be effected through establishment of the following: (1) due care in the extension of hospital facilities; (2) system of annual extension of hospital privileges and staff appointments; (3) strict enforcement of the rules and regulations. All open hospitals should be strictly controlled if they are to attain the standard of efficiency of the 'closed' hospital.

*Anesthesia.* The choice of anæsthetic depends upon the type of case, the operation, and the anæsthetist. The use of ethylene as an anæsthetic has been claiming more attention in recent years. So far as known, the safety of this anæsthetic depends upon the following conditions: (1) efficient

administration of the anæsthetic, (2) freedom of the anæsthetic and operating rooms from static electricity—in this connection, it is to be noted that proximity of the X-ray department should be guarded against, (3) known humidity of the air in order that it should not exceed the margin of safety. The use of a hydrometer to gauge the humidity is desirable. When a humidifying apparatus with a thermostat can be installed the humidity may be kept at a definite point.

Ethylene, according to Dr. John Lundy, Rochester, Minnesota, has been administered 33,000 to 34,000 times in The Mayo Clinic without accident. Nitrous oxide with oxygen is a safe anæsthetic in expert hands because of the readily available supply of oxygen. Local anæsthesia under proper conditions and technique has made splendid progress in recent years.

*Clinical laboratory work.* The clinical laboratory should be made self-supporting as far as possible. The system of charges is still a controversial question, but the flat rate is favored by the majority of hospitals. The flat rate should include the cost of tissue examination, but there should not be any charge for autopsies. In the flat rate method there is sometimes need for restriction. The proponents of the schedule of individual charges believe that this is the best method to regulate laboratory work. They believe that the doctor or interne should say what laboratory work is required rather than leave it to be determined by a routine flat rate method.

Apparently, not all doctors appreciate the full value and importance of laboratory work and too often cases which come up for discussion in the staff conference show a distinct lack of sufficient laboratory work. This makes it clear that there is still need to educate doctors in this matter. Laboratory technicians should be well trained, having at least 1 or 2 years in a recognized university. Such a course is now being given at the University of Minnesota. Laboratory work from the outside should be guardedly accepted by an approved hospital. The American College of Surgeons requires that, to be acceptable, laboratory work handled outside the hospital must be done in a laboratory approved by the Council on Medical Education and Hospitals of the American Medical Association or in the clinical laboratory of a hospital approved by the American College of Surgeons. This is necessary to insure efficient and reliable service.

*Legal responsibility of hospitals.* The legal responsibility of hospitals through their governing bodies or boards of trustees is becoming more and more clearly defined. There are a great

One person—in this instance the chief resident physician—was appointed to make the request for permission for autopsy. Each month a report was given at the staff meeting of the number of autopsies performed which was compared with that of the previous months. Members of the medical staff and personnel, before having the right to solicit postmortems, signed a statement agreeing such examination upon their own bodies. To derive full benefit from these studies the pathologist was accorded sufficient time, assistance, and equipment to present his findings at staff meetings.

#### Discussion

FRANK J. NOVAK, JR., M.D., Chicago. Post-mortems in this country are lamentably few. First I thought the fault lay with the interne, then I thought the fault lay with the medical schools, but now I believe that when a candidate is admitted to a medical school some machinery should be devised to determine whether that particular potential student has within him that divine spark of curiosity, so needed. If such students and only such students, were admitted to the schools it would not be necessary to hold meetings to discuss plans and methods of obtaining autopsies, for the men would insist upon them.

#### NEED FOR CONSULTATIONS IN THE CASE OF THE SERIOUSLY ILL

FRANK H. LAHEY, M.D., Boston. The doctor called in consultation should be furnished with all necessary information and, if possible, the physician in charge of the case should be present. A nurse should not accept a consultation unless it is in written form. When hospitals can establish the spirit in their midst that a consultation will be given with every helpful desire and with the very least degree of criticism then they will have accomplished the greatest good.

I do not believe every nurse should work in the operating room for a surgeon and run the operating table. It is infinitely better that there be a graduate, experienced operating nurse provided, and that the nurses obtain their training under these graduate nurses.

I feel very strongly in accord with everything that has been said regarding the development of anesthesia, we can no longer be satisfied with the relegation of anesthesia to relatively inexperienced people, neither can surgeons rightfully assume the position that they are in control of anesthesia. The anesthetist today must be accepted as a clinician. He estimates risks, segregates the cardiovascular, determines the selective

type of anesthesia which fits certain individuals, experiments in preliminary narcosis etc. A standard of anesthesia should be adopted, although this standard should be elevated only gradually to these ideal heights, out of consideration for certain institutions without extensive financial resources. The ideal scheme of anesthesia, which is not always possible, is for the anesthetist to work as largely as possible with the limited group of men with whom he can establish and keep an intimate contact.

#### Discussion

JOHN S. HARGER, M.D., Chicago. Borderline conditions as well as serious cases warrant consultations free from prejudice in which the patient's best interests are primary. Practically all hospital cases are now influenced by the counsel of the laboratory technician, the roentgenologist, the pathologist, and an able diagnostician. The serious case is always entitled to counsel regardless of the patient's financial status and in borderline cases the surgeon should have the counsel of the internist and vice versa. Often times several consultants representing many specialties are necessary to reach a satisfactory conclusion. Consultations, however, increase hospital costs unless the work is being carried on in a charitable institution or unless there is that *esprit de corps* among the staff members whereby advice can be secured without the usual consultation fee.

#### ROUND TABLE CONFERENCES

The following topics were discussed at conferences conducted by Malcolm T. MacEachern, Chicago, and Robert Jolly, Houston.

*Case records.* Accurate and complete case records should be kept for private as well as public patients. No distinction should be made. There are various methods in vogue for securing case records through the attending doctor, the interne, the graduate nurse, or the trained record librarian; the latter two when it is impossible to secure internes. When secured through the interne, the graduate nurse and the record librarian their data and findings must be supervised by the attending doctor himself. The interne should make the physical examination but this must be checked over by the attending doctor. When the record is secured by the graduate nurse and the record librarian the attending doctor must add the physical findings. Sometimes arrangements can be made with the young graduate of medicine practicing in the community to assist with case records providing such a plan

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## THE MECHANISM OF OBSTRUCTIVE PULMONARY ATELECTASIS<sup>1</sup>

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**A**QUIRED massive pulmonary atelectasis may be either compressive or obstructive. The relation of compression to an airless state of the lung, such as occurs in large intrapleural accumulations of fluid or air, extreme distortion of the thoracic cage, tumors etc. has long been understood, but only recently has definite proof of the causal relation of bronchial obstruction to atelectasis been furnished by direct observation in man and reproduction in animals. Other causes than these have been suggested and may possibly account for some cases.

We were led recently to question the bronchial obstruction theory as the result of seeing several dogs with total stenosis of a bronchus fail to develop atelectasis. We then repeated the experiments of others in animal reproduction and did not secure their results. It was apparent that factors unknown to us and essential to atelectasis formation, must have been different in our experiments. Further analysis of the mechanism involved was undertaken to determine these factors, and the results are presented here.

### ETIOLOGICAL HYPOTHESES

As introduction, a brief review of the various etiological hypotheses for massive atelectasis is necessary. Complete presentations (8, 9, 10) and exhaustive bibliography (4) are obtainable elsewhere. The literature reveals the following etiological hypotheses:

1 *Decreased respiratory force.* Pasteur (26 and 27) found "massive collapse" of the lung in cases of postdiphtheritic paralysis of the diaphragm, and he attributed the airless state to reduction in depth of respiration. The mechanism was not more precisely described than to suggest that the lower lobes not employed in respiration spontaneously lost their air content.

Likewise, Bradford, in discussing the occurrence of massive atelectasis in wounds of the chest wall, considered it secondary to the immobilization and retraction which took place on that side of the chest. The immobilization was thought to be the result of reflex spasm of respiratory muscles.

2 *Disturbance of pulmonary circulation.* Gwyn's analysis of 18 cases of massive atelectasis left the question of etiology obscure, and he suggested the possibility of a vasomotor disturbance of the lung. The mode of its origin and action he did not attempt to explain.

3 *Bronchial obstruction.* Massive atelectasis has been seen frequently in association with inflammatory conditions of the lungs and the likelihood of its following obstruction of the bronchi by inflammatory exudates has received much attention. Thus, Bartels described the condition in the pulmonary complications of measles. Postoperative collapse of the lung was attributed by Schrammer to bronchial irritation, local spastic contraction,

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many decisions on record which make the law quite clear. In the absence of statutory provisions in the various states, practically all the higher courts support the theory that the governing body or board of trustees is legally responsible to the extent of exerting due diligence and care in the selection of those who work in the hospital. Though the relation of master and servant cannot be said to exist between the hospital and the physicians and surgeons attendant on it, the hospital does nevertheless assume the responsibility in that it uses its own judgment or that of its trustees in selecting them and impliedly therefore undertakes to exercise reasonable care to get such as are skillful and trustworthy in their profession.

The patient has a right to rely on the exercise of such care and consequently if through neglect of the hospital to exercise it receives an injury the patient is entitled to look to the hospital for indemnity unless the hospital enjoys some extraordinary exemption from liability as might be afforded by a special act of the legislature as in the case of the State of Massachusetts."

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The Conference was brought to a close by a unanimous resolution of appreciation tendered to the American College of Surgeons for the service it is rendering the field through its Hospital Standardization Department.



Fig. 1. Bronchial plug Michelin mastic after removal a tightly fitting cast

in some animals with whining, grunting, panting, and struggling and in others it was induced by occluding the trachea partially with each expiration. The periods of time were varied.

The experiments were divided into four groups depending upon the type of respiration, whether quiet or straining, and the type of bronchial obstruction whether total or valvular. Typical protocols are given.

a. Quiet respiration with total bronchial obstruction occurred in 14 dogs.

Dog 774A showed quiet respiration with total obstruction of the middle lower and accessory lobe bronchi on the right under general anesthesia. No atelectasis resulted.

By hypodermic injection 0.060 grams of morphine and 0.004 grams of atropine were given. Ether anesthesia was induced and tracheotomy done. Through the tracheotomy opening a solid plug of dumb bell shape was inserted in the right primary bronchus. Positive pressure intratracheal anesthesia was used (25) and the chest was opened on the right by intercostal incision and a ligature was passed around the primary bronchus just proximal to the branch to the middle lobe. The lungs were then fully inflated and the ligature tied tightly compressing the bronchial wall into the groove of the plug. The wound was then closed with care to avoid pneumothorax. The respirations were maintained quiet and shallow by continuing deep ether anesthesia. The dog was sacrificed 13½ hours later.

Autopsy showed the plug securely obstructing the bronchi of the right middle lower and accessory



Fig. 2. Dog 1. A. Photomicrograph. Air containing lung after 45 days of bronchial obstruction and quiet respiration.

lobes. These lobes were fully air containing and without trace of atelectasis.

Dog 455A showed quiet respiration with total obstruction of the right lower and accessory lobe bronchi under morphine narcosis. The dog was sacrificed 24 hours later. No atelectasis resulted.

Morphine 0.166 grams and atropine, 0.004 grams were administered. With the dog in a profoundly somnolent state a bronchoscope was passed and the bronchi of the right lower and accessory lobes were packed tightly with 'Michelin mastic' which is a malleable sticky rubber preparation commonly used to stop leaks in automobile tires. The bronchoscope was then removed and the dog allowed to lie quietly in morphine sleep for 24 hours. Then, a few minutes before sacrificing 5 cubic centimeters of a watery solution of methylene blue was instilled into the bronchus proximal to the obstruction, to prove its effectiveness.

The autopsy showed the larger bronchi of the lower and accessory lobes tightly filled by a cast of the elastic medium (Fig. 1). The dye had not penetrated past this obstruction. Indeed the air in the lobes did not escape on their removal from the chest. These lobes were inflated to a normal degree and except for echymotic patches secondary to trauma could not be distinguished from the other lobes.

Dog 122A showed quiet respiration and total cicatricial stenosis of the right lower lobe bronchus. After 45 days the dog was sacrificed. No atelectasis resulted.

After the administration of 0.166 grams of morphine a stick of silver nitrate was introduced bronchoscopically and a 1 centimeter length of the bronchus lying well within the lower lobe was cauterized. The dog was allowed to live under routine kennel care. For a few days it was quiet and without appetite then became normal. No respiratory symptoms presented themselves. Sacrifice was made at the end of 45 days.



and plugging of the narrowed lumen with mucus Lord recognized it in various types of suppurative disease of the lower respiratory tract

4 *Combined factors* The most generally accepted hypothesis includes both bronchial block and decreased respiratory force (6, 7, 12, 16, 19, 20, 21, 22, 24) For instance, Jackson and Lee express their conception of the process leading to massive atelectasis in quoting Elliot and Dingley "Consequent to immobilization of the thoracic wall and diaphragm, irrespective of its cause, secretion collects in the bronchioles and even in the larger bronchi, sufficient to prevent the egress of air, and leads to a gradual absorption of the alveolar air by the pulmonary circulation and ultimate collapse and airlessness of the lung tissue" A somewhat different mechanism is suggested by others (8, 13, 14, 32), who suppose the obstructing plug to have a ball valve action in the tapering lumen of the bronchus, permitting air to escape from the lung in expiration and not allowing it to be inspired

Bronchial block plus vasomotor disturbances are believed by Scott and Cutler (30, 31) to explain atelectasis, but these authors offer no detail as to mode of action

#### EXPERIMENTAL REPRODUCTION

Section of the phrenic nerves in animals has resulted in pulmonary atelectasis in the hands of a few (7, 26, 29), but this has not been regularly the case For example, Alexander not only divided one phrenic but also all intercostal nerves and the external respiratory nerve on one side in dogs and in man without causing massive atelectasis of the underlying lung The operation of phrenicotomy as routinely performed is not followed by this condition

The researches of Lichtheim, in 1878, are frequently referred to in support of the bronchial block theory He occluded the bronchi of rabbits with foreign bodies and by ligature, and found the affected lung lobes airless a few days later The loss of air was presumed to be by blood stream absorption Unfortunately, sterile technique was not employed in operating and such complications as pneumonia and compressive atelectasis from empyema

and pneumothorax interfered with the validity of the conclusions

Massive atelectasis has been obtained experimentally with uniformity by three groups of workers Lee and his associates (21) plugged the bronchus of a dog with thick mucus obtained bronchoscopically from a patient with massive collapse of the lungs, in other dogs mucilage of gum acacia was used Within a few hours thereafter, the heart and diaphragm appeared in the X-ray to be displaced toward the side of the plug No necropsy proof of atelectasis was given Coryllos and Burnbaum later blocked the bronchus with an inflated rubber balloon and obtained X-ray and necropsy evidence of massive atelectasis Bronchoconstrictor effects were produced by Dixon and Brodie with drugs and vagal stimulation, and it was found that when respiration was quiet and the expiratory phase was lengthened, massive atelectasis resulted

The experiments that follow deal with the mechanism of atelectasis formation after bronchial block, particularly as regards respiration, whether quiet or straining, bronchial obstruction, whether total or valvular, fate of pent up air, rate of development, and intrathoracic pressures

#### EXPERIMENTS

The experiments were carried out under morphine and ether anesthesia or with heavy doses of sodium barbital or morphine alone Adult, medium sized dogs (body weight, 13 to 15 kilograms) were employed, and care was taken to exclude those with pre existing respiratory disease The experiments were concluded by electrocution (17) to avoid agonal phenomena, and the lungs were examined both grossly and microscopically

1 *Type of respiration* In dogs in which bronchial obstruction had been instituted, the effect of the type of respiration upon the formation of atelectasis was determined Two types of respiration were contrasted, namely, quiet breathing of normal or shallow depth and what may be termed straining i.e. breathing in which there is interference with the discharge of air from the lungs to the extent of requiring muscular effort to effect it Straining respiration occurred spontaneously



Fig. 5 Dog 773A Photomicrograph of a section of an atelectatic lung after straining respiration and bronchial obstruction.



FIGURE 6

Fig. 6 Dog 647A Lungs Atelectasis of right lower lobe after straining respiration and valvular bronchial obstruction

tion was thus carried on for 10 hours until the dog was sacrificed.

At autopsy the plug was found firmly occluding the right lower and accessory lobes and these were collapsed deep purplish blue in color non crepitant and of the consistency of muscle (Fig. 4). When detached and placed in water they sank. Microscopic examination revealed a completely airless state of the parenchyma (Fig. 5). Other lung lobes were normal in appearance.

d. Straining respiration with valvular bronchial obstruction was produced in 19 dogs.

Dog 647A showed straining respiration with valvular obstruction of the right lower lobe bronchus under general anesthesia. Five hours later the dog was sacrificed and complete atelectasis of the right lower lobe was found.

Sodium barbital 4.2 grams was intraperitoneally injected and produced light anesthesia. Tracheotomy was done and a wooden cannula was inserted in the bronchus to the right lower lobe and connected to a water valve as in Dog 482A. Straining respiration was induced as in Dog 773A. Immediately with each expiration a stream of air bubbles escaped from the water valve outlet and continued to do so for about 1 hour after which no more appeared. The dog was sacrificed 5 hours later.

Autopsy showed the cannula firmly fixed in the bronchus of the right lower lobe and that lobe was completely atelectatic as in Dog 773A (Fig. 6).

The results of 36 experiments of the types illustrated above are collected in graphic form in Figure 7 contrasting the effects of quiet with straining respiration in the presence of bronchial obstruction. The periods of obstruction varied from 2 to 24 hours and the amounts of atelectasis from 0 to 100 per cent

of the affected lung parenchyma. Quiet respiration was obtained in 10 dogs and straining in 22 dogs. The former developed no atelectasis or any degree of lung deflation, and the circles, which represent them, are situated over "0" at the left on the scale of atelectasis, while the latter uniformly had atelectasis from 12 to 100 per cent as represented by the dots distributed to the right. Four circles contain numerals and refer to experiments intended for quiet breathing but in which the animals panted or accumulated mucus obstruction in the trachea. Here straining occurred spontaneously to slight extents and corresponding amounts of atelectasis were found.

2. *Type of bronchial obstruction.* The effect of obstruction of the bronchus by a heavy mucilage of gum acacia according to the experiments of Lee *et al.* (21), was investigated, and it was found that atelectasis resulted only when the respirations were straining in type. Thus, 2 dogs with quiet respiration obstructed for 12 hours, showed no deflation of the affected lobes and 2 others with straining breathing and the same sort of obstruction developed atelectasis.

3. *Fate of air pent up in the lung.* The experiments serve to indicate the manner of disappearance of air from the lung during the development of obstructive atelectasis, (a) in total and (b) in valvular bronchial obstruction.

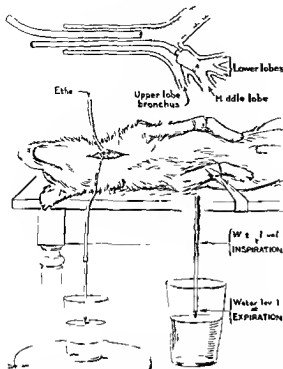


Fig. 3 Dog 482A Method for water valve bronchial obstruction. Above Cannula inserted in right primary bronchus below water valve apparatus set up right behavior during quiet respiration

Autopsy showed that the lungs were normal in appearance except for fibrous adhesions between the right lower and accessory lobes. Section into the right lower lobe showed the medial division of the bronchus to be destroyed over a length of about 2 centimeters and replaced by a mass of firm necrotic tissue encapsulated in scar tissue. This caused a complete interruption of the bronchial lumen and the bronchioles in the periphery were distended with viscous glassy mucus. The parenchyma supplied by this section of the bronchial tree was however not different in appearance from that of other parts of the same and other lobes. It was normally air containing and floated in water. The vessels were intact. Microscopic examination of the parenchyma revealed bronchioles everywhere distended with mucus and alveoli inflated (Fig. 1).

The first acute type of experiment was performed 7 times the second subacute experiment 4 times and the third chronic one 3 times.

b. Quiet respiration with valvular bronchial obstruction was instituted in 4 dogs.

Dog 48A showed quiet respiration with valvular obstruction of the right lower and accessory lobe bronchi under general anesthesia. The dog was sacrificed 3½ hours later. No atelectasis was found.

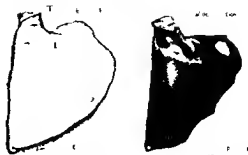


Fig. 4 Straining contrasted with quiet respiration as to atelectasis formation. At right Dog 773A Lower lobe. Total atelectasis after straining and bronchial obstruction. At left Dog 803A Lower lobe. Air-containing condition after quiet respiration and bronchial obstruction.

Morphine 0.100 grams and atropine 0.001 grams were given. Ether anesthesia was used and tracheotomy done. A wooden cannula was wedged snugly into the right primary bronchus and from this a rubber tube led out of the trachea. Attached to the tube was a glass cannula and the tip of this was submerged in water. The anesthesia was maintained by insufflation (Fig. 3). The dog was allowed to lie breathing quietly for 3½ hours and the glass cannula was observed in order to determine the behavior of the pent up bronchial air. With each inspiration the water was drawn up about 10 centimeters and at expiration its meniscus was lowered again to the water level. These levels remained constant during the entire period. No air escaped.

The dog was sacrificed and autopsy showed the plug tightly lodged and cannulating the lower and accessory lobe bronchi. These lobes presented no atelectasis or deflation.

c. Straining respiration with total bronchial obstruction was seen in 14 dogs.

Dog 73A showed straining respiration with total obstruction of the right lower and accessory lobe bronchi under general anesthesia. Ten hours later the dog was sacrificed and complete atelectasis of the obstructed lobes was found.

Morphine 0.050 grams and atropine 0.001 grams were given. Anesthesia was induced by ether. After tracheotomy a solid dumb bell shaped plug was inserted and ligated into the right primary bronchus as in Dog 774A obstructing the branches to the lower and accessory lobes. Resistance to expiration was instituted as follows. A steady current of air laden with ether vapor sufficient to carry a light anesthesia was insufflated into the open trachea and the tracheal lumen was partially closed. The resistance thus created to expired air was not great enough to produce an intratracheal pressure of 3 millimeters of mercury and since the dog is capable of exerting much higher pressures than this the lungs did not suffer undue distention. Straining respiration

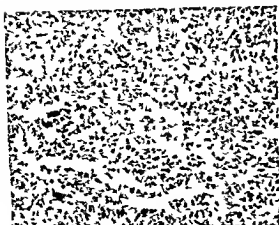


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At autopsy the plug was found firmly occluding the right lower and accessory lobes and these were collapsed deep purplish blue in color non crepitant and of the consistency of muscle (Fig 4). When detached and placed in water they sank. Microscopic examination revealed a completely airless state of the parenchyma (Fig 5). Other lung lobes were normal in appearance.

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Autopsy showed the cannula firmly fixed in the bronchus of the right lower lobe and that lobe was completely atelectatic as in Dog 773A (Fig 6).

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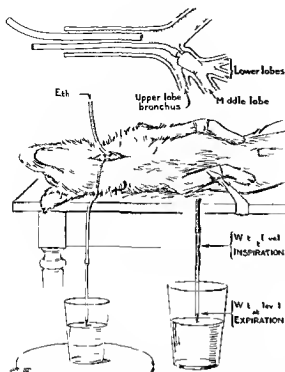


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The first acute type of experiment was performed 7 times the second subacute experiment 4 times and the third chronic one 3 times.

b Quiet respiration with valvular bronchial obstruction was instituted in 4 dogs.

Dog 48 A showed quiet respiration with valvular obstruction of the right lower and accessory lobe bronchi under general anesthesia. The dog was sacrificed 3½ hours later. No atelectasis was found.

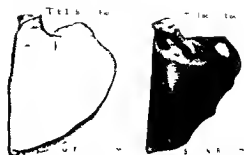


FIG. 4 Straining contrasted with quiet respiration as to atelectasis formation. At right Dog 773A. Lower lobe. Total atelectasis after straining and bronchial obstruction. At left Dog 803A. Lower lobe. Air-containing condition after quiet respiration and bronchial obstruction.

Morphine 0.000 grams and atropine 0.001 grams were given. Ether anesthesia was used and tracheotomy done. A wooden cannula was wedged snugly into the right primary bronchus and from this a rubber tube led out of the trachea. Attached to the tube was a glass cannula and the tip of this was submerged in water. The anesthesia was maintained by insufflation (Fig. 3). The dog was allowed to lie breathing quietly for 3½ hours and the glass cannula was observed in order to determine the behavior of the pent up bronchial air. With each inspiration the water was drawn up about 10 centimeters and at expiration its meniscus was lowered again to the water level. These levels remained constant during the entire period. No air escaped.

The dog was sacrificed and autopsy showed the plug tightly lodged and cannulating the lower and accessory lobe bronchi. These lobes presented no atelectasis or deflation.

c Straining respiration with total bronchial obstruction was seen in 14 dogs.

Dog 7,3A showed straining respiration with total obstruction of the right lower and accessory lobe bronchi under general anesthesia. Ten hours later the dog was sacrificed and complete atelectasis of the obstructed lobes was found.

Morphine 0.070 grams and atropine 0.001 grams were given. Anesthesia was induced by ether. After tracheotomy a solid dumb bell shaped plug was inserted and ligated into the right primary bronchus as in Dog 7,4A obstructing the branches to the lower and accessory lobes. Resistance to expiration was instituted as follows: A steady current of air laden with ether vapor sufficient to carry a light anesthesia was insufflated into the open trachea and the tracheal lumen was partially closed. The resistance thus created to expired air was not greater than to produce an intratracheal pressure of 3 millimeters of mercury, and since the dog is capable of exerting much higher pressures than this the lungs did not suffer undue distention. Straining respiration



Fig 9 Dog 839A. Right lung. Role of pulmonary circulation in atelectasis for matation. Right above accessory lobe vessels intact. Complete atelectasis after valvular obstruction and straining. Right below lower lobe vessels ligated. Partial atelectasis after valvular obstruction. Center middle lobe vessels intact. Complete atelectasis after total obstruction. Left upper lobe vessels intact. Air containing condition without bronchial obstruction.

bronchus showed straining respiration under general anesthesia. After sacrifice of the dog 2 hours later the findings were: accessory lobe normally inflated, lower lobe collapsed to 25 per cent of normal size and 95 per cent atelectatic.

Morphine 0.033 grams and atropine 0.001 grams were given. Ether anesthesia was used and tracheotomy was done. The bronchi of the accessory lobe were plugged with Michelin mastic as in Dog 455A, and a dumb bell shaped cannula was tied into the bronchus of the lower lobe. The cannula was connected with a water valve and straining respiration was carried on for 2 hours. Air escaped from the valve with each expiration during the first 1/2 hour. The dog was then sacrificed.

At autopsy the plugs were found firmly in place. The accessory lobe was normally air containing. The lower lobe was shrunken to 25 per cent of normal size and 95 per cent of the parenchyma was atelectatic (Fig 10).

Dog 842A was used for a repetition of the preceding experiment with a shorter period of obstruction. After 40 minutes the dog was sacrificed. The results were: accessory lobe (total obstruction) normally inflated, lower lobe (valvular obstruction) collapsed to 25 per cent of normal size and without atelectasis.

Analysis of the results of 20 experiments of this sort shows the rate of atelectasis formation to be quite variable in different individuals and to depend upon the amount of exertion in the straining respiration and upon the

type of obstruction. Thus, total obstruction rarely caused more than 25 per cent atelectasis in 6 hours, whereas valvular plugs brought about high grades of the condition within 2 hours. In those dogs which strained forcefully and had efficient valvular plugs, collapse of the affected parts of the lung took place within a few minutes, although actual atelectasis developed later. For example

Dog 843A with valvular obstruction of bronchus of entire right lung showed straining respiration under general anesthesia. Measurement of escaping air was made and serial X ray photographs were taken. The results showed that 500 cubic centimeters of air escaped and there was marked mediastinal shift in 2 minutes; the right lung was reduced to 20 per cent normal size and was 25 per cent atelectatic.

Morphine 0.016 grams and atropine 0.001 grams were given. Ether anesthesia was induced. After tracheotomy a cannula was tied into the right primary bronchus to include all branches and was connected with a water valve and collecting flask as in Dog 839A. The animal was then placed under the X ray tube and upon a plate changing tunnel and was arranged in true dorsal recumbent position. An exposure was made (Fig 11 a) and then straining respiration was instituted. Repeated exposures were taken at intervals thereafter, care being taken that the position of the animal was not altered. The air that escaped was measured and symptoms noted.

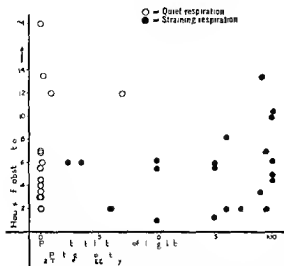


Fig 7 Chart of 36 experiments. Straining contrasted with quiet respiration as to atelectasis formation. Total or valve obstruction.

a Total bronchial obstruction and straining respiration was observed in 4 dogs.

Dog 769A with total obstruction of right lower and accessory lobe bronchi and ligature of the blood supply to the accessory lobe showed straining respiration under general anesthesia. After 6 hours the dog was sacrificed. The results were atelectasis of the lower lobe and failure of atelectasis of the accessory lobe.

Morphine 0.100 grams and atropine 0.001 grams were given and ether anesthesia induced. A solid dumb bell shaped plug was inserted and ligated into the right primary bronchus as in Dog 774A obstructing the branches to the lower and accessory lobes. The bronchus and vessels to the accessory lobe were separately ligated care being exercised that the lobe was left inflated to the normal degree. Straining respiration was then instituted for 6 hours after which the dog was sacrificed.

At autopsy the bronchial plug and ligatures were intact. The right lower lobe was deflated and largely atelectatic. The accessory lobe was normally air-containing and differed in appearance from unobstructed lobes only in having a somewhat cyanotic hue (Fig 8).

b Valvular and total bronchial obstruction and straining respiration were produced by 2 dogs.

Dog 839A with valvular obstruction of right lower and accessory lobe bronchi, total obstruction of the middle lobe bronchus and ligature of the blood supply to the lower lobe showed straining respiration under general anesthesia. Escaping air was measured. After 10½ hours the dog was sacrificed. The result was atelectasis of the middle lower and accessory lobes.

Morphine 0.100 grams and atropine 0.001 grams were given and ether was used to induce anesthesia.



Fig 8 Dog 769A. Role of pulmonary circulation in atelectasis formation. Right lower lobe vessels intact. Partial atelectasis after bronchial obstruction and straining. Left accessory lobe vessels ligated. Air-containing condition after same.

Tracheotomy was done. A wooden cannula was inserted in the right primary bronchus and connected to a water valve after ligating the vessels to the right lower lobe. The mouth of an inverted Erlenmeyer flask filled with water was submerged over the water valve outlet to receive air that might escape. Straining respiration was then instituted. Within 10 minutes 125 cubic centimeters of air collected in the flask, at the end of 1 hour 150 cubic centimeters of air had collected. No more appeared. The dog was sacrificed 10½ hours later.

Autopsy showed the bronchial cannula securely in place communicating freely with the lower and accessory lobes. The sides of the cannula obstructed completely the opening to the middle lobe bronchus. The lower lobe was collapsed and showed scattered areas of atelectasis; the accessory lobe was totally atelectatic and the middle lobe was almost totally atelectatic (Fig 9).

4 Rate of development. The rate of formation of obstructive pulmonary atelectasis was studied in relation to the type of obstruction, total or valvular. The amount of deflation of the obstructed lung was estimated in four ways: viz approximate estimation by observation of the proportion of atelectatic to air-containing parenchyma; measurement by submersion in water of the volume of the lung in proportion to its volume when re-inflated; measurement of the volume of air given off through a valve obstruction and determination by X-ray photographs of the degree of mediastinal shift.

Dog 841A with total obstruction of accessory lobe bronchus and valvular obstruction of lower lobe

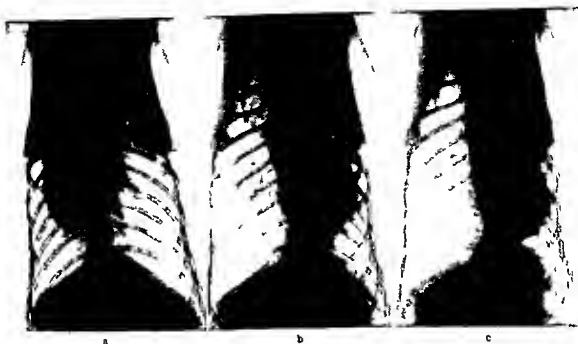


Fig 11 Dog 843A Serial roentgenograms Valvular obstruction and rate of atelectasis formation a Status

b before straining respiration c after 2 minutes of straining d after 2 hours of straining

paralysis, reflex spasm from painful injuries, pull of the collapsed lung, etc.) reduced force of breathing has become generally accepted as essential to the formation of atelectasis. Thus quiet breathing is believed to promote the accumulation of excessive bronchial secretions in dependent parts and, after bronchial obstruction has occurred, to favor absorption of the imprisoned air by the blood stream. From this hypothesis has arisen the practice of stimulating the respirations for the prevention and treatment of atelectasis. Deep breathing is encouraged by suggestion and eliminating sedatives or is enforced by carbon dioxide inhalations and coughing is induced by slapping the chest and rolling the patient from side to side. Under these circumstances more or less relief has been reported.

That diminished force of respiration is secondary rather than primary to atelectasis one is convinced of by observing the breathing movements of a dog with massive obstructive atelectasis of one lung. The affected side of the chest here as in man is seen to be drawn in and comparatively immobile, but symmetry of respiratory excursions returns immediately



Fig 12 Dog 843A Lungs Result of valvular obstruction and 2 hours of straining Right lung collapsed and largely atelectatic (Fig 11)



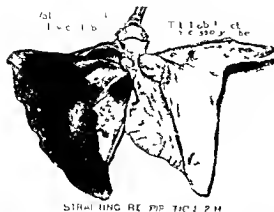


Fig 10 Dog 341A Total contrasted with valvular obstruction as to rate of atelectasis formation Straining respiration for 2 hours Right accessory lobe Air containing condition after total obstruction Left lower lobe Atelectasis after valvular obstruction

In 2 minutes 500 cubic centimeters of air had escaped and the mediastinum had shifted markedly to the right (Fig 11 b)

At the end of 15 minutes 25 cubic centimeters more of air had escaped and there was slightly greater mediastinal displacement The right side of the chest was noticeably depressed and motionless There was no distortion of the diaphragm nor any dyspnoea

After 58 minutes no more air was given off The left lung field appeared denser X-ray pictures taken at the end of 83 minutes and 120 minutes showed no change (Fig 11 c) The dog was sacrificed

Autopsy showed the heart lying entirely in the left side of the chest and the diaphragm drawn up asymmetrically to a level distinctly higher than normal The entire left lung was collapsed to 20 per cent of its normal size and presented extensive areas of atelectasis The right lung was enormously over distended and emphysematous (Fig 12)

5 *Pattern of development* The specimens removed at various stages in the development of atelectasis in the above experiments presented a consistent pattern of origin and spread of alveolar collapse The first alteration from the normal was uniform deflation as occurs with simple pneumothorax collapse The lung was reduced in size but crepitant and without change in appearance Atelectasis or complete alveolar collapse, then began in the hilus region as a sharply defined, irregular, purplish blue area which was depressed, non crepitant and of the consistency of muscle tissue The atelectasis gradually extended toward the periphery in irregular,

finely demarcated outline The peripheral margins were the last to become involved This centrifugal progression of atelectasis is illustrated by Figure 13 It was the same whether the obstruction was total or valvular

6 *Intrathoracic pressures* The intrapleural and intrabronchial pressures were investigated during the development of obstructive atelectasis The results of the following experiment were typical of 3 that were performed

Dog 645A with valvular obstruction of right lower and accessory lobe bronchi showed straining respiration under general anesthesia Pressures within the pleura and the obstructed bronchi were measured At the end of 70 minutes the dog was sacrificed The findings were atelectasis of lower and accessory lobes and depression of intrabronchial and intrapleural pressures

Morphine 0.084 grams and atropine 0.001 grams were administered Ether anesthesia was induced After tracheotomy a cannula was inserted in the right primary bronchus and connected with a water valve A side tube from this led to a water manometer to indicate the pressures within the obstructed bronchial tree A pleural cannula was inserted and connected with a second water manometer Periodic readings were taken from each manometer at inspiration and expiration before and after the start of straining respiration The dog was sacrificed at the end of 70 minutes

The readings are plotted in Figure 14 The curves represent the inspiratory pressures—the upper the intrabronchial and the lower the intrapleural The perpendicular lines indicate the expiratory excursions With the onset of straining air began to escape from the water valve and the intrapleural pressures began to fall from the initial level of -160 and -167 millimeters of water and reached -290 and -342 millimeters of water in 53 minutes when air ceased to escape There was then a slight rise before termination of the experiment The intrabronchial pressures behaved differently for starting at -10 and -80 millimeters of water the expiratory pressure diverged from the inspiratory The latter fell in a manner similar to the intrapleural pressures although more rapidly and the former rose to atmospheric pressure At the end of 53 minutes each tended to return to its former level

At autopsy the cannula was found firmly in place in the bronchus to the lower and accessory lobes and these lobes were atelectatic

#### DISCUSSION

Diminished respiratory excursion with retraction of one side of the chest is seen quite strikingly in association with massive atelectasis of the underlying lung and whatever the interpretation of this has been (diphtheric



Fig 11 Dog 843A. Serial roentgenograms. Valvular obstruction and rate of atelectasis formation. a Status

b before straining respiration c after 2 minutes of straining d after 2 hours of straining

paralysis, reflex spasm from painful injuries, pull of the collapsed lung, etc.) reduced force of breathing has become generally accepted as essential to the formation of atelectasis. Thus quiet breathing is believed to promote the accumulation of excessive bronchial secretions in dependent parts and, after bronchial obstruction has occurred, to favor absorption of the imprisoned air by the blood stream. From this hypothesis has arisen the practice of stimulating the respirations for the prevention and treatment of atelectasis. Deep breathing is encouraged by suggestion and elimination of sedatives or is enforced by carbon dioxide inhalations and coughing is induced by slapping the chest and rolling the patient from side to side. Under these circumstances more or less relief has been reported.

That diminished force of respiration is secondary rather than primary to atelectasis one is convinced of by observing the breathing movements of a dog with massive obstructive atelectasis of one lung. The affected side of the chest here as in man is seen to be drawn in and comparatively immobile, but symmetry of respiratory excursions returns immediately



Fig 12 Dog 843A. Lungs. Result of valvular obstruction and 2 hours of straining. Right lung collapsed and largely atelectatic (Fig 11)

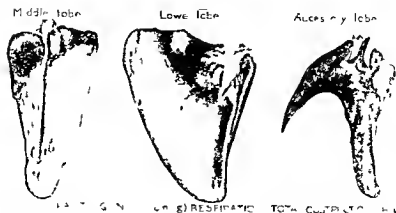


Fig. 13. Dog 803. Pattern of atelectasis formation. Left middle lobe. Beginning atelectasis. Center lower lobe. Advancing atelectasis. Right accessory lobe. Total atelectasis.

after pneumothorax is induced and the chest wall released from the pull of the collapsed lung beneath.

As to the prevention and treatment of atelectasis we are not at all in a position to dictate, for these experiments have dealt with occlusion of the normal lung and permit no certain predictions as to the behavior of the inflamed or otherwise abnormal lung with bronchial obstruction such as is presented usually in clinical cases of massive atelectasis. Indeed further study in hand is already indicating that the mechanism of atelectasis formation in the pathological lung is more complex than hitherto represented. But we are able positively to say as to the normal lung that any mode of breathing that entails expiratory effort against resistance encourages absorption of pent up pulmonary air. The work of others (7) has shown that cough aids in eliminating fluids which lie in the larynx, trachea, and largest bronchi only and drives still farther into the periphery those lying more deeply. Viscid material like mucus contained in the lumen of a bronchus tends to adhere to its walls during both phases of respiration and after escape of the tidal air to move back and forth rather than to allow air to pass. It is therefore misleading to apply to the case of obstruction by secretions the teachings of Jackson and his school as to the behavior of rigid foreign bodies in the bronchi for the latter do not conform themselves to luminal

alterations unless impacted and may permit air to be inspired with the inspiratory enlargement of the bronchus. We feel that the present state of our knowledge of the dynamics of bronchial obstruction and of the circumstances attending the absorption of captive pulmonary air under clinical conditions is too meagre to permit judgment even as to the safety of such active measures as have been used for intervention in atelectasis. It may well be, for instance, that coughing and straining promote instead of prevent lung collapse in the inflamed as well as the normal organ and precisely how hyperpnea may act to reinflate a lung sector whose bronchus is clogged with mucus is yet to be explained. Bronchoscopic aspiration of mucus in this condition should be reserved for those who are extraordinarily skilled in the technique and certain of being able to avoid additional irritation to the bronchial mucosa else the operation may have to be repeated. Certain passive measures in prevention and treatment are probably advantageous and these permit gravity to assist ciliary action in removing secretions. Wet patients should be placed in a partial Trendelenburg position and turned occasionally from side to side. If lung collapse has already occurred the affected side should remain uppermost.

It is a curious circumstance that air which is imprisoned within the normal lung under conditions of quiet respirations remains with

out absorption for a long time, if, indeed, it is ever absorbed, whereas air introduced into the neighboring pleural cavity or into the tissue spaces elsewhere tends quickly to disappear. Perhaps the query is more pertinent as to why air, and especially the nitrogenous part of it, at any point should be absorbed, and this may be elucidated by determining what factor of straining respiration it is which accounts for air removal from the occluded lung.

Those experiments designed to test the part played by the blood stream in atelectasis formation must be guarded as to interpretation. In ligating the vessels the nerves to the lung may also have been injured, and the failure of air absorption under these circumstances (and with bronchial plugging and straining breathing) may have been due to either or both of the effects. The part played by the nerve supply is now under investigation.

Experiments with valvular bronchial obstruction have been included in the presentation because of the striking part that this form of block had in discarding air from the lung during straining respiration and because the means were thereby afforded of studying the pressures within the occluded bronchus. But we wish most emphatically to prevent the impression that these experiments were supposed to portray the circumstances of spontaneous bronchial obstruction in man since we doubt that material of any sort is capable of acting within the bronchus as a valve to permit residual air to escape from the lung. This matter also is receiving further consideration experimentally.

Reference to Figure 14 shows that after formation of atelectasis the pressures within the occluded bronchus and the pleural cavity are considerably depressed. Lowered intrapleural pressure in this condition was first noted by Elkin and is the result of lung shrinkage within resisting parietes. Estimation of the intrapleural pressure should be a simple and reliable clinical diagnostic procedure in massive atelectasis.

Attention should be called to the fact that atelectasis spreads in a lung lobe from the hilus toward the periphery and not in the opposite direction, as commonly supposed (9).

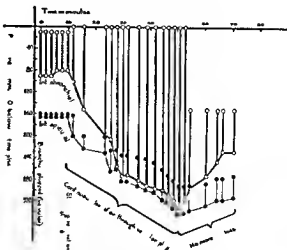


Fig. 14. Dog 6454. Chart of intrabronchial and intrapleural pressures (expiratory and inspiratory) during development of obstructive atelectasis.

The latter idea has arisen from finding at autopsy patches of airless parenchyma along the lung margins and interpreting them to be the early stages of massive atelectasis. Such lesions are probably due to obstruction of peripheral bronchioles.

#### CONCLUSIONS

The conclusions may be summarized as follows:

1. Quiet or suppressed respiration with bronchial obstruction does not lead to pulmonary atelectasis in the normal lung.
2. Straining respiration is essential to the production of obstructive pulmonary atelectasis in the normal lung.
3. Valvular obstruction produces atelectasis much more rapidly than does total obstruction, but there is no evidence that valvular obstruction occurs spontaneously in man.
4. Pent up bronchial air is probably lost from the lung by blood stream absorption.
5. Obstructive atelectasis develops centrifugally through the lung parenchyma.
6. Decreased intrapleural and intrabronchial pressures occur characteristically in obstructive pulmonary atelectasis.

#### BIBLIOGRAPHY

1. ALEXANDER, J. Personal communication.
2. ARCHIBALD, E. and BROWN, A. *Am Rev Tuberc* 1927 xvi 111.
3. BARTELS. *Arch f path Anat* 1861 xxi 129.

- 4 BOWEN D Am J Roentgenol 1929 xxi 101
- 5 BRADFORD J Bull et mêm Soc de méd d hôp de  
Par 1917 vii 719
- 6 BRISCOE J Lancet 1914 i 1502
- 7 Idem Quart J Med 1906 viii 93
- 8 CHURCHILL I Arch Surg 1925 vi 489
- 9 CORAYLOS I and BIRNBAUM G Arch Surg 1928  
xvi 501
- 10 DIXON W and BRODIE T J Physiol 1903 xxx 97
- 11 ELAIN D Ann Surg 1917 lxxvi 88
- 12 ELLIOT T and DRAGLEY L Lancet Lond 1914  
i 1305
- 13 GAIRDNER W Brit & For Med Chir Rev 1853  
vi 453
- 14 GRAILEY and HEWITT Keynolds System of Medicine  
1871 p 865
- 15 GWYN N Tr Ass Am Physicians 1923 xxxviii 411
- 16 HIRSCHBOECK F Am J M Sc 164 268 19 7
- 17 HIRSHIN L J Lab & Clin M In press
- 18 JACKSON C and LEE W Tr Am Surg Ass 19 5  
viii 723
- 19 LEE W Ann Surg 19 4 lxxix 506
- 20 LEE W TUCKER G and CLERF L Ann Surg  
1928 lxxxviii 6
- 21 LEE W TUCKER G RAYDIN I and PANDER  
GRASS E Ann Surg 1928 lxxxviii 15
- 22 Idem Arch Surg 1929 xviii 242
- 23 LICHTHEIM Arch f exper Path u Pharmacol 18,8  
x 54
- 24 LORD F Diseases of the Bronchi Lungs and Pleura  
Philadelphia 1913
- 25 MELTZER S Med Rec 1910 lxxvii 411
- 26 PASTEUR W Am J M Sc 1890 c 242
- 27 Idem Tr Clin Soc Lond 1895 xxviii 111
- 28 SCHIRMER F Surg Gynec & Obst 19 1 xxvii  
486-492
- 29 SCHROEDER W and GREEN F Am J M Sc 190  
cxxx 196
- 30 SCOTT W Arch Surg 1925 x 73
- 31 SCOTT W and CITLER E J Am M Ass 19 3 cx  
1759
- 32 SEWALL H Am Rev Tuberc 19 1 iv 811

## HÆMANGIOMA OF TENDON AND TENDON SHEATH

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IT is the purpose of this report to direct attention to an interesting group of vascular neoplasms of tendons and tendon sheaths. Angiomata, located in unusual places, are not infrequently seen but are seldom correctly diagnosed. Those deep angiomata found in muscle, bone and nerve have been sporadically recorded in the literature. Sato (1) reported angiomatous involvement of the median nerve. Stewart and Bettin recounted similar disease of the sciatic nerve and its branches. Mondor and Huet published a comprehensive survey of 186 cases of angiomata of muscles. Hitzrot collected 26 cases of angiomata of bone. Osgood wrote of a case of angioma of the knee joint in which the infrapatellar fat pad was the seat of disease.

However, angiomata originating in tendons and tendon sheaths are possibly the rarest of these types and consequently, they are not frequently considered in the diagnosis of tendon tumors. A review of the literature reveals but 10 cases. In 1913 Weil reported 6 cases including those of Delageniere, Richet, Partsch, and Gottstein. Janik, Chauvin and Roux, and Schwartz have each described a case with definite anegetic tendencies. Faldini has recently reported a case of a lymph angioendothelioma arising from the tendon sheaths on the medial aspect of the ankle, with definite metastatic tendency.

To these cases we wish to add 6 hitherto unpublished ones. We are concerned with angiomata arising primarily from tendons and their sheaths, whose presence gives rise to a question of diagnosis—not with the multiple discrete or diffuse type of angioma in which tendons are only incidentally involved (Cruveilhier, Barling).

CASE 1. C. E. D. admitted to the clinic January 16, 1924, complained of pain which began in the left knee 6 years earlier. More or less steady pain had been present about an inch above the knee cap. The patient limped when the pain was severe. No history of trauma existed except that of a mild injury to the knee 2 years prior to the onset of the

symptoms described. No constitutional symptoms were discovered. The general examination revealed nothing unusual. The local examination showed an extremely sensitive area  $1\frac{1}{4}$  inches above the upper edge of the patella, at the outer border of the quadriceps tendon. When the muscle was contracted, the sensitive spot could be found. When the muscle was relaxed, one could palpate under the edge of the tendon and elicit pain. There was  $\frac{3}{4}$  inch atrophy of the thigh. The reflexes were normal. The X-ray showed several free bodies in the knee joint. All laboratory tests were negative. The pre-operative diagnosis was traumatic myositis.

The patient was operated upon by Dr. Steindler on February 14, 1924. Just external to the joint synovia and arising from the quadriceps tendon was a red blue circoid appearing mass. It did not pulsate. On being cut into, it bled profusely. The tumor was resected with the adjacent tissues, since it had infiltrated the immediately surrounding muscles and tendons. Not all of the quadriceps tendon could be resected. A compression bandage was applied. The wound healed well and 6 months later no recurrence had been noted. In December 1928, 3½ years later, the patient was again operated upon because of persistent aching in the region of the first operation. No evidence of recurrence could be made out. Scar tissue binding the quadriceps tendon to the femur was resected. Relief was obtained by this procedure. Incidentally, a port wine hemangioma  $2\frac{1}{2}$  inches square was found over the nape of the neck. He stated it had been present since infancy and enlarged with the full of the moon. Seen again in March 1929, he was completely free from symptoms. He lacked 15 degrees of having full flexion of the knee.

The pathological report showed that the gross specimen consisted of a formless mass of tissue measuring 5 by 2 by 3 centimeters. It was made up of numerous spaces lined with a shiny membrane. A tab of fatty tissue was attached to it. Only one section of the tumor was made. It showed very large spaces lined by endothelium. These spaces anastomosed and were often separated by thin septa of fibrous tissue. Beneath the spaces was a dense fibrous tissue. The pathological diagnosis was cavernous angioma.

CASE 2. D. P., a girl aged 10 years, was admitted August 10, 1925, with a growth on the left little finger and on the left wrist which had been present since birth and which had continued to increase in size commensurate with her own growth. There was no pain. At times during illnesses, as when she had measles, the hand and wrist became flexed and a clonic tremor appeared. When the finger was pricked the blood spurted much higher than when



Fig. 1 Cavernous hemangioma (4 millimeters Leitz objective)

another finger was punctured and bleeding was harder to stop. When the finger was elevated it became narrower and almost normal; when depressed it became full and pulsed. The finger had always been bluish. The mother stated that the tumor in the wrist varied in size and often caused pain.

Physical examination was negative except for the local condition. A soft subcutaneous non-tender fluctuating mass was present on the palmar aspect of the distal phalanx of the little finger. Both the nail and the skin covering the entire distal phalanx were cyanotic. The end of the finger was the size of a hickory nut. In the left wrist, just radial to the flexor tendons, was a soft fluctuating mass about 3 centimeters in diameter. It was not tender and did not pulsate.

The patient was operated upon by Dr. Peterson August 13, 1935. Under ether anesthesia, boiling saline was injected into different portions of the finger growth. An incision was made over the mass in the wrist and on cutting through the vaginal fascia a blue mass was found adherent to the sheath of the flexor tendons. (The exact tendons are not mentioned.) The tumor was carefully dissected and it was necessary to remove part of the tendon sheath. The tumor involved the sheath and merely enveloped the unaffected tendons. Closure was in layers.

The pathological report was as follows: the specimen consisted of a small, irregularly shaped piece of tissue encapsulated. Many red areas were visible. Microscopically the tumor was seen to consist of rather dense fibrous tissue surrounding many large spaces. These spaces contained blood and all were lined by a single layer of endothelium. The diagnosis was cavernous hemangioma.

The patient returned for re-examination on June, 1926. About 2 years earlier she had noticed that a swelling was beginning to appear in the upper portion of the anteromedial aspect of the forearm. This swelling had been gradually enlarging and spreading. Occasionally the elbow joint seemed momentarily fixed in flexion. During the last 6 months she had noticed a swelling just medial to the operative scar of last year. Sharp cutting pains had been present in the region of the old scar. Examination at this time showed the old scar on the anterolateral portion of the forearm. Along the anteromedial aspect of the entire forearm there was a soft fluctuating swelling, more or less divided into halves. The lower half was very soft, not discolored, and not attached to the skin. The upper half showed more diffuse changes. The tumor blended with the tissues in the antecubital fossa. No inflammatory characteristics were discernible. On the little finger medially was a bluish soft swelling.

The patient was re-operated upon by Dr. A. Kolodny on June 14, 1926. An incision 4 inches long was made along the swelling in the upper third of the forearm. The tumor was beneath the vaginal fascia, embedded in the muscle tissue. It was extremely diffuse and infiltrating. A partial resection requiring abundant ligations was done. Complete removal of the angiomatous tissue would have necessitated complete resection of the forearm muscles. The tumor apparently had spread upward from the distal portion of the forearm where the angiomatous mass was found to envelop all the tendons on the flexor side of the forearm. At the wrist another incision revealed a similar tumor infiltrating and surrounding the tendons. Portions of the tumor were removed. It was deemed inadvisable to go further since it was very difficult to control the persistent oozing of blood from the seat of the tumor mass. The wounds were closed with catgut and beeswax silk. A few small areas of infection prolonged healing. X-ray therapy was then started and continued to August 3, 1927, at which time no gross recurrence had been made out. The skin about the scars remained purplish and somewhat nodular in places. The finger was unchanged. The patient has not been seen since then.

The pathological report showed a gross specimen consisting of a small piece of reticulated tissue which suggested a tumor of blood vessel origin. Two sections were made, both showing much striated muscle tissue and fat. Both sections showed that the tumor invaded muscle. The tumor tissue consisted of large spaces lined with endothelial cells and filled with red blood cells. In places the tumor was replaced by a dense fibrous tissue. No mitotic figures were seen. The diagnosis was cavernous hemangioma (Fig. 1).

CASE 3. L. S. 1, a negro aged 4 years, had been treated at this hospital for infantile paralysis for 4 years. During the last 6 months of that time the mother had noticed a lump on the outer side of the left leg about 5 inches above the ankle. It occasioned

an increase in the limp when the child was up and about for unusual periods. No change in the size of the lump had been observed. Inspection of a 4 year series of photographs showed the presence of this mass in each picture. It had apparently passed unnoticed by both patient and doctor. The relevant findings were these: on the lateral aspect of the left leg in its lower third was a small tumor 5 by 4 by 4 centimeters which, while not fluctuant was soft and slightly mobile. It was deeper than the subcutaneous tissue, the skin above it appearing normal. The tumor did not seem to move with contraction of the peronei. No nodes were present and there were no other tumors. The tumor was thought to be a fibroma.

The patient was operated upon on May 6, 1928 by Dr. Burman. By a curved incision over the tumor the vaginal fascia was exposed. Under this fascia and adherent to it over an area 2 centimeters square was seen a bluish tumor mass. The fascia was incised laterally to the tumor, exposing it where upon it was seen that the apparently angiomatous mass completely interrupted the course of a thin tendon of the peronei group running down to the cuboid. This probably was the peroneus cuboideus tendon (Cunningham in discussing these anomalies of the peroneal tendons states that the peroneus longus and peroneus brevis may be fused together and that additional slips may be present such as the peroneus accessorius, the peroneus digiti quinti, the peroneus calcaneus externus and the peroneus cuboideus). The tendon above and below the tumor frayed out to disappear into it. The tumor had no pedicle. It was located 10 centimeters below the origin of the muscle belly.

The tendon was severed above and below the tumor which was removed with the portion of the vaginal fascia investing its superior surface. The distal end of the tendon was sewed to the peroneus longus and the wound was closed in layers. Healing was uneventful. The tumor apparently had its origin in the tendon.

The pathological report made by Dr. Hansmann was as follows: the specimen consisted of a fusiform mass of tissue. At each end of the mass was a tendon which appeared to be frayed as it entered the mass. The mass was red and on section appeared to contain blood. The tissue was soft and did not have any characteristic appearance but suggested more than anything else a hemorrhage into the tendon sheath. Microscopically the tumor consisted of many papilla-like projections which were lined by endothelium. Between the projections were collections of blood. The tumor was probably a cavernous hamangioma. Another section taken through the tendon and the tumor showed the tumor infiltrating the tendon distally and proximally. In places only a few strands of tendon tissue remained to separate cavernous spaces (Fig. 2). In the center of the tumor no evidence of tendon structure could be made out. The exact origin of the tumor could not be determined but it was most probably from the tendon



Fig. 2. Cavernous hamangioma has invaded peroneal tendon. Tendon tissue on left. Tumor on right. (4 millimeters Leitz objective.)

itself since no definite sheath was seen. (Tendons which pursue a straight course need no sheath, according to Mayer.)

The patient was seen again in December, 1928 and was symptomless. No recurrence was noticed.

CASE 4. Miss M. W., aged 22 years, complained of a nodule of 17 months' duration in the left popliteal space. Seventeen months prior to admission, the patient had had a generalized attack of joint pains involving most of the joints. This passed and left no residua in its train. A few weeks later, the patient had noticed a small mass behind the left knee. It had fluctuated in size and at times the back of the knee had seemed swollen. At the time of examination it was not as large as it often had been. It occasioned her some discomfort since she felt it move about as the knee was flexed and extended.

Along the internal border of the popliteal space, there was a walnut sized firm discrete mass not subcutaneous which became apparent when the knee was extended and which slipped under the hamstring tendons when the knee was flexed. It was slightly tender to pressure. General examination was negative. The pre-operative diagnosis was either fibroma or chronic bursitis.

The operation was performed by Dr. Miltner July 1, 1928. An incision 3 inches long was made over the internal hamstrings 2 inches above the knee joint. Originating from the semi tendinosus tendon was a white tumor 5 by 2 by 2 centimeters firm to palpation and separate from the vaginal fascia above it. Its base of attachment measured 2 by 1 centimeters. There was little bleeding when the pedicle of attachment to the tendon was severed. The operative diagnosis was fibroma. The post-





Fig 3 Sclerosing capillary hemangioma. Beneath the capsule appeared endothelial lined spaces. Lower half of section is of hyalinized connective tissue (16 millimeters Leitz objective)

operative course was uneventful. The patient was discharged symptomless and was still without symptoms 6 months later.

The pathological report by Dr Hansmann showed that the specimen consisted of a very firm white tumor  $4\frac{1}{2}$  by 2 by 1 centimeters. The mass was fairly well encapsulated and appeared to be made up of layers of connective tissue. Between the layers of fibers were slit like spaces which appeared to be lined by synovia. The tumor was definitely a fibroplastic neoplasm. Microscopically, the neoplasm had a definite capsule. The tumor showed many small blood vessels, the majority of which were capillary in size and many of which were not yet canalized. These vessels were all lined by endothelium. In a few places there was a perithelial growth with concentric layers of endothelial cells. The central and major portion of the mass consisted of interlacing bundles of hyalinized connective tissue. The tissue outside the capsule was very acellular with the capillary spaces sclerosed. The pathological diagnosis was a sclerosing type of capillary hemangioma (Fig 3).

CASE 5 H C S, aged 57 years was admitted January 2, 1909. He complained of swelling of the volar surface of the wrist and pain in the wrist and fingers of 2 years duration. The onset had been insidious and the complaints had gradually grown worse especially during the past year. Recurrent attacks of pain radiating into the fingers had bothered him considerably. There had been a steady increase in the size of the wrist swelling during the past year. Nothing seemed to make it smaller. General history elicited nothing relevant. There was

no familial tendency to angiomas or congenital anomalies. The general examination showed nothing unusual. No skin naevi were found.

The right hand was reddish cold and perspiring. On the volar aspect of the right wrist appeared a soft non tender swelling. It covered the lower quarter of the forearm and seemed to be divided into two lateral portions by the flexor tendons. When the wrist was flexed and the finger flexors contracted the tumor almost disappeared apparently being located below the vaginal fascia. The skin and subcutaneous tissue were freely movable over the mass. No nodules were palpable. Movements of the wrist and fingers were entirely free. Tendon contraction elicited an aching pain in the palm and fingers especially the middle finger. X ray was negative. Blood pressure was 100-95. The pre-operative diagnosis was hemangioma or myeloma of the flexor tendon sheaths.

The patient was operated upon by Dr A Stender January 23, 1909. A midline incision 5 inches long was made over the volar surface of the wrist severing the carpal ligament. Beneath the vaginal fascia but not adherent to it was a blue red spongy layer enveloping the flexor tendons and the ulnar and median nerves. This neoplastic tissue extended along the tendons into the palm of the hand. Upon incision it bled moderately. It did not seem to infiltrate the tendons, muscles or nerves but simply to adhere to them. It was easily stripped off. The tendons were stained a bright canary yellow. All visible tumor tissue was carefully dissected out and the wound closed in layers. The patient made an uneventful recovery. Five weeks later he had no pain. The fingers appeared to be a little stiff he believed but improvement was continuous.

Dr Hansmann made the following pathological report: the sections showed a rather vascular tissue with abundant yellowish brown pigment both extra cellular and intracellular (phagocytosed). New capillary vessels were being formed or attempts at such were being made even though the lumina were devoid of blood. This therefore was a capillary hemangioma and the pigment was the result of degenerated blood from hemorrhage. The tendon except for its yellow stain grossly showed nothing remarkable. There was no involvement of the tendon tissue. The diagnosis was capillary hemangioma (Fig 3).

CASE 6 Through the kindness of Dr Carl Mathewson of Fresno, California, we are enabled to report the occurrence of a hemangioma recently removed from the tendon of the plantaris muscle in the case of Dr Wilkie at the University of Edinburgh. The tumor appeared in a female aged 26 years and had been present for several years. It had commenced increasing in size 2 years before admission. There had been no pain. On operation it was found to be the size of a lemon and as firm as one. It was encapsulated and arose from the tendon of the plantaris muscle. Pathological section revealed a cavernous hemangioma. A slide which we were

able to examine was of tissue closely similar to that of the tumor in Case 3. No evidence of malignancy was apparent.

#### ETIOLOGY

Burton has wondered why tendon sheath tumors are not more common since the sheath is only a specialized connective tissue, and since tendons are often exposed to trauma and to the irritative processes of infection. It is equally a matter for speculation why angiomata of tendons and their sheaths are so rare. Mayer in his work on tendons has demonstrated that their blood supply, although much less than that of muscle or the neighboring connective tissue, is much better than has been taught. Except near its friction bearing surface, tendon tissue contains numerous blood vessels, derived mainly from 3 sources: (1) the muscular branches; (2) the vessels running in the paratenon, mesotendon, and the vincula; and (3) the vessels from bone and periosteum near the insertion of the tendon. Yet these vessels are rarely subject to angiomatous change; it would seem. A tendon sheath and a joint are analogous structures, functionally and anatomically. It is interesting to observe how uncommon angiomata are in both structures.

As regards the ultimate etiology, it is Ewing's opinion that certain vascular segments retain their embryonal character and that the congenital origin of the tumor speaks a tissue predisposition. Ribbert suggested that the tumor process, an aberrant vascular germ, resides in an isolated segment of the vessel wall and that after it has been latent for a time, it develops independently into a tumor. Among other hypotheses may be mentioned the fissural theory of Virchow and that of Rokitsansky and Borst wherein angiomata represent simple hypertrophy of vascular segments without neoplastic tendencies.

Angiomata in general appear to be congenital. Fitzwilliams, in a study of 645 cases of angiomata, found 83.2 per cent which had been observed at birth, and an additional 12.7 per cent which had appeared during the first 3 years of life. Sixteen per cent of the patients volunteered a positive family history. However, of the tendon angiomata reported, only 3 had been noticed at birth. No one of these

3 presented a positive family history. The influence of trauma is very questionable. It may serve only to attract attention to the tumor. Trauma occurred in more than one half of all the cases previously reported as well as those in our series, but was usually mild. Two thirds of the patients were women. This corresponds to the observation that most types of angiomata apparently occur more often in women. In the first decade of life there were 3 cases, between the ages of 20 and 30 years there were 6 cases, and between the ages of 40 and 50 years there were 3 cases, and there was only 1 case in the sixth decade. The age was not stated in 2 cases.

#### SYMPTOMS

Pain is typical as a symptom and Weil believed it to be due to angiolithic concretions, rather than to nerve pressure. While this may be true in some cases, yet in Partsch's case (reported by Weil) the pain was typically over the distribution of the median nerve and over the dorsal branch of the radial nerve, while in our Case 5, the pain was referred along the distribution of both the median and the ulnar nerves. Pain is usually absent for a long time and manifests itself most often with an increase in the size of the tumor. Pain may appear soon after the initial trauma or may develop much later. It varies commonly from a sensation of discomfort to steady, continuous aching. More rarely, it may be described as sharp and cutting. Excision of the tumor is usually followed by complete relief of pain, while recurrence of the growth is accompanied by recrudescence of pain.

The patient as a rule notices the swelling late, as in our Case 3, where it was overlooked for 4 years, as a study of a series of photographs later revealed. Trauma may direct attention to the tumor. The swelling may vary in size and is often dependent on the position of the limb. Ulceration of the skin is reported in one case. As a rule, the skin is not adherent to the tumor, since the tumor lies beneath the ensheathing or vaginal fascia of the extremities. In most cases, the tumor remained unchanged in size for years, or increased very slowly coincidentally with the

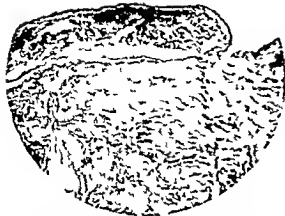


FIG. 3. Sclerosing capillary hemangioma. Beneath the capsule appeared endothelial lined spaces. Lower half of section is of hyalinized connective tissue. (16 millimeters focus objective.)

operative course was uneventful. The patient was discharged symptomless and was still without symptoms 6 months later.

The pathological report by Dr. Hansmann showed that the specimen consisted of a very firm white tumor  $4\frac{1}{2}$  by 2 by 1 centimeters. The mass was fairly well encapsulated and appeared to be made up of layers of connective tissue. Between the layers of fibers were slit like spaces which appeared to be lined by synovia. The tumor was definitely a fibroplastic neoplasm. Microscopically the neoplasm had a definite capsule. The tumor showed many small blood vessels, the majority of which were capillary in size and many of which were not yet canalized. These vessels were all lined by endothelium. In a few places there was a perithelial growth with concentric layers of endothelial cells. The central and major portion of the mass consisted of interlacing bundles of hyalinized connective tissue. The tissue outside the capsule was very acellular with the capillary spaces sclerosed. The pathological diagnosis was a sclerosing type of capillary hemangioma. (Fig. 3).

CASE 5. H. C. S. aged 57 years was admitted January 2, 1929. He complained of swelling of the volar surface of the wrist and pain in the wrist and fingers of 2 years duration. The onset had been insidious and the complaints had gradually grown worse especially during the past year. Recurrent attacks of pain radiating into the fingers had bothered him considerably. There had been a steady increase in the size of the wrist swelling during the past year. Nothing seemed to make it smaller. General history elicited nothing relevant. There was

no familial tendency to angiomas or congenital anomalies. The general examination showed nothing unusual. No skin nevi were found.

The right hand was reddish, cold and perspiring. On the volar aspect of the right wrist appeared a soft, non tender swelling. It covered the lower quarter of the forearm and seemed to be divided into two lateral portions by the flexor tendons. When the wrist was flexed and the finger flexors contracted the tumor almost disappeared, apparently being located below the vaginal fascia. The skin and subcutaneous tissue were freely movable over the mass. No nodules were palpable. Movements of the wrist and fingers were entirely free. Tendon contraction elicited an aching pain in the palm and fingers, especially the middle finger. Ray was negative. Blood pressure was 100-95. The preoperative diagnosis was hemangioma or myeloma of the flexor tendon sheaths.

The patient was operated upon by Dr. A. Steindler January 23, 1929. A midline incision 3 inches long, was made over the volar surface of the wrist, severing the carpal ligament. Beneath the vaginal fascia but not adherent to it was a blue-red spongy layer enveloping the flexor tendons and the ulnar and median nerves. This neoplastic tissue extended along the tendons into the palm of the hand. Upon incision, it bled moderately. It did not seem to infiltrate the tendons, muscles or nerves but simply to adhere to them. It was easily stripped off. The tendons were stained a bright canary yellow. All visible tumor tissue was carefully dissected out and the wound closed in layers. The patient made an uneventful recovery. Five weeks later he had no pain. The fingers appeared to be a little stiff, but believed but improvement was continuous.

Dr. Hansmann made the following pathological report: the sections showed a rather vascular tissue with abundant yellowish brown pigment both extracellular and intracellular (phagocytosed). New capillary vessels were being formed or attempts at such were being made even though the lamina were devoid of blood. This therefore was a capillary hemangioma and the pigment was the result of degenerated blood from hemorrhage. The tendon except for its yellow stain grossly showed nothing remarkable. There was no involvement of the tendon tissue. The diagnosis was capillary hemangioma. (Fig. 3).

CASE 6. Through the kindness of Dr. Carl Mathewson of Fresno, California, we are enabled to report the occurrence of a hemangioma recently removed from the tendon of the plantaris muscle in the clinic of Dr. Wilkie at the University of Edinburgh. The tumor appeared in a female aged 6 years and had been present for several years. It had commenced increasing in size 2 years before admission. There had been no pain. On operation it was found to be the size of a lemon and arose from the tendon of the plantaris muscle. Pathological section revealed a cavernous hemangioma. A slide which we were

volved once the tendon of Achilles, the extensor of the fourth toe, the semi tendinosus, the quadriceps, an anomalous peroneal tendon, and the tendons in the medial aspect of the ankle, tibialis posticus, and flexor hallucis longus. No cases of multiple extremity involvement are reported. The tendons and the tendon sheaths of the fingers apparently escape.

Macroscopically, the tumor appearance is fairly typical, although it may look like a fibroma. One type (Cases 2 and 5) apparently originates from the tendon sheath and may not involve the tendon (Case 5, where red clusters of tumor lay free between the uninvolved flexor tendons at the wrist). Another type originates from the tendon (Cases 1, 3, 4, and Schwartz's case). In this the tendon is infiltrated by the tumor tissue, which may disrupt its fibers and destroy it, with interruption of continuity (Fig. 3). The tumor arising from the sheath envelops the tendons, especially at the wrist, and ultimately may become adherent to them so that dissection may be difficult. The tendons in Case 5 were stained a remarkable canary yellow color, presumably from the blood pigment released in repeated extravasations following injuries to the thin walled sinuses. The discrete sclerosing forms are apt to be attached by a definite base to the tendon, the diffuse forms tend to infiltrate the neighboring tissues, whether fascia, muscle or tendon, forming many nodules, pin sized to lentil sized, aggregated in red clusters. The mass may be well encapsulated or poorly so. The color of the tumor is usually bluish red. A definite pedicle is not made out in the tumors arising obviously from the sheath. In the more diffuse types, isolated angiomas of muscles may be present. Muscle invasion may extend to the point of replacement by tumor. The nerves are not infiltrated, running unchanged through the tumor mass (Case 5).

Grossly, the tumor usually shows many spaces lined with a shiny membrane and filled with fresh blood. It is usually soft and red on section, though it may not always be so, depending on the amount of fibrous tissue thrombi, and concretions present. The color may vary from light brown to red and the sur-

face of the cut section may be striated. The microscopic structure of these tumors is usually that of cavernous angioma. Two of the present series were of the capillary angioma type with an unusual amount of fibrous tissue. The tumor may be of the mixed type and may contain cartilage and fibrous tissue (Chauvin and Roux). Metastasis does not usually take place, though it occurred in Faldini's case.

#### DIAGNOSIS

The diagnosis is usually difficult, especially in the discrete type. The clinical history is helpful. The presence of skin angiomas may be suggestive, as in our Cases 1 and 2. Pre-operative aspiration of the tumor will show fresh blood. The X ray may demonstrate the presence of angiolithic concretions. Ruggles recently has again called attention to this. These concretions appear as numerous, small, cyst like masses, varying from 1 millimeter to 1 centimeter or more in diameter, with a thin shell, an irregular mass in the center. The spots are scattered throughout the tumor and are taken to represent calcification of thrombi in the cavernous loops.

#### DIFFERENTIAL DIAGNOSIS

Juxtatendinous affections are not always easily delimited and many cases have been mistaken for tendon sheath tumors, though seldom for angiomas. Malignancy of the skin is not likely to be confusing. Tumors of the vaginal fascia, myelomatous (Christopher) and angiomatous (Biancheri) are reported. Biancheri described an angioma arising from the vaginal fascia over the vastus internus, which had become adherent to periosteum and bone. This very probably originated in the vaginal fascia which, on the inner side of the thigh, blends with the muscle fascia over the adductors and runs down to insert into the femur along the inner lip of the linea aspera.

Tumors of muscles, especially angiomas, develop at the level of the muscle belly. Differentiation may be difficult, however. Localized myositis ossificans may also be confused in this connection. Periosteal affections, especially tumors, may invade tendon sheaths secondarily. The converse may be true, that a tumor of a tendon sheath, usually sarcoma,

general growth. In other instances, the growth was rapid at first, but later became stationary. In still others, at some period in the history of the tumor, generally following a mild trauma, it began to enlarge rapidly.

Functional restriction is usually absent for years, or may be very mild. In the upper extremity, extension of the fingers may be interfered with. Finger and wrist movements may feel stiffer than normal and pain may be elicited in executing complicated movements as in piano playing. Movements of the thumb may be lessened to the point of fixation. During illness, as in measles, one patient developed clonic tremors of the fixed hand and wrist. The effect of menstruation and of gestation has not been remarked upon. In the lower extremity there may be present a mild limp. Equinus developed in one case (Schwartz). Sensory changes do not occur apparently, though one patient complained of formication in the fingers.

#### SIGNS

The size of the tumor varies. It may be as small as a hazelnut or larger than a fist (cf. Case 6). In its growth it may ulcerate the skin (Delageniere) with the production of a serosanguineous discharge. The tumor may be discrete and sharply outlined or it may be diffuse, poorly outlined and irregular so that, at operation it is usually larger than anticipated. Its consistency soft, firm, fluctuant, or elastic, depends on the amount of fibrous tissue present. It may be painful to pressure and to touch or only to pressure. This latter is attributed to the angiolithic concretions which may be outlined as tender nodules on palpation of the mass. Its composition is not always uniform since it may also contain thrombi and dense connective tissue strands. The tumor may be reducible or irreducible, this factor being possibly determined by the ratio of fibrous tissue to angiomatous tissue. In some cases an increase in the size of the tumor can be observed when the limb is in a dependent position and a decrease in size can be noted when the limb is elevated. Circular compression of the limb may increase the size of the tumor. With the pendent position of the limb, the overlying skin may appear deeper hued, even violaceous

and varices may appear. Varices large enough to resemble a varicose tumor, have been reported present at the base of the tumor.

The tumor may pulsate. A souffle, soft and intermittent may be heard. Seldom is a thrill felt. In 2 cases, subcutaneous angiomata of the finger tips were concomitant. It is noteworthy, however, that no case showed skin nevus over the tumor. Monod describes a peculiar discoloration of the skin, sometimes associated with deep angiomata, which may be caused when the tumor breaks through the vaginal fascia. However, until the tumor involves the vaginal fascia and subcutaneous tissue, the skin will remain freely movable over it.

In advanced cases (as Case 2) involvement of the adjacent muscle may occur. The localizing signs are indicative of the intimate attachment of the tumor to a tendon or tendons. Pain on motion may be elicited and disturbance of function frequently observed. The tumor may be palpated, may be made to stand out and may be seen to move with the tendon (Case 4). It can, therefore be moved horizontally much better than vertically. The tumor may obliterate tendon prominences. In the wrist the tendons have been observed to overlie the tumor and divide it into two lateral portions (Case 5). The tumor may follow the course of the tendon or sheath involved and may extend below the annular ligament of the wrist (Case 5).

#### PATHOLOGY

These angiomata tend in statistics at least to favor the left side of the body. They are not symmetrical, as lipomata tend to be (Stewart and Bettin). Their favorite site is in the lower third of the forearm. Both the upper and lower extremities may be involved, the upper much more frequently. In the upper extremity, the tendons involved in their order of frequency have been flexor profundus digitorum, flexor sublimis digitorum, carpal flexors of wrist, supinator longus, abductor pollicis, extensor longus pollicis, and extensor carpi radialis. The growths seem to favor the flexor side but may involve the extensor side by extension (Pavisch). In the lower extremity the following were each in

place. They may occur in conjunction with the cartilaginous tumors of bone (Buxton).

Sarcomata of tendon sheaths are malignant and infiltrating. About 47 cases have been recorded. Ayres and Markoe early outlined the syndrome. As a rule, myeloplaxes are absent and there is no lipid. Mixed tumors not infrequently appear.

Tumors of tendons proper are comparatively rare and Ombredanne and Buxton believe they do not exist. They think that the growth arises primarily from the tendon sheath and that the tendon is simply encroached upon. In an advanced case, it is difficult to feel sure as to the origin of the tumor. Angiomata, as in Case 3, have hitherto not been reported. Fibromata, osteomata, and sarcomata are recorded. Buxton believes osteoma of tendon to be a disease akin to myositis ossificans. Ollerenshaw has described a bilateral giant cell sarcoma apparently primary in the tendo achillis associated with xanthelasma. Jolkwer reported a unique cysto endothelioma of a tendon, occurring in the flexor tendon of the middle finger. The tumor contained a thick gray fluid and was composed of concentric layers of endothelial cells. A similar case has been observed by the present authors. The so called tendon ganglion as described by Thorn belongs to this group.

Inflammations of tendons and their sheaths are the most common affections encountered in diagnosing tendon lesions. Traumatic, pyogenic, gonorrhœal, syphilitic, and tuberculous tenosynovitis form a group whose description is not within the scope of this paper. The neuropathic tenosynovitis of Chipault deserves note. Aspiration will decide the diagnosis in many cases in which the history, physical examination, and X-ray findings are inconclusive. Rheumatic tenosynovitis may occur in conjunction with arthritis. Baracz reported on tendinitis arthritica achillea in rheumatic patients. The swelling surrounds the tendons and extends from the heel insertion to the origin of the tendon. Single nodules in the tendon are often palpable and the author conceives them to be depositions of urates. It is undoubtedly more common than the sparse accounts would lead one to believe. Since tendon sheaths are akin to joints and

burst this picture is probably correct. This may be the fibroformative tenosynovitis of which Tournaux speaks. It may simulate a tumor due to its papillomatous outgrowths. Similarly, chronic inflammatory tumors of tendons have been described by Fergue (Tournaux) and Klotz. The ganglion, a degenerative cyst of the tendon sheath wall is not likely to occasion confusion. Its location and character are fairly typical. The recent article of Carp and Stout covers the subject comprehensively.

#### PROGNOSIS

The outlook in angiomata of tendon sheaths is good, both in regard to the lack of recurrence and ultimate good function. Many cases are definitely cured. In the diffuse, infiltrating types, recurrence may take place. Yet the prognosis, even in these, is fair. Function in all cases was good. If we exclude the case of Faldini, there has been observed no tendency to malignancy or metastasis.

#### TREATMENT

Radical excision of the tumor, whenever possible, is the treatment of choice, and this was the procedure followed in every case, except that of Richet in which a coagulating material was used. One case had X-ray treatment for recurrence following excision. The treatment was apparently successful only in so far as no additional recurrence appeared during a year's observation. In the treatment of angiomata in general, considerable success has been reported. Thus Andren recommends filtered radium emanations in the treatment of deep angiomata, using small doses at intervals of considerable length. Of 50 deep angiomata seen by him, 45 were so treated. Of these cases 28 were reported cured and 15 improved. Eller similarly prefers the use of radium. He also advises the use of bipolar endothermy. Ludwig von Babo 50 years ago recommended the use of many irritating substances for injection, such as sulphuric acid, iodine, bichloride of mercury, and trichloroacetic acid. Thermocautery and galvanocautery have been used. Spontaneous involution may rarely take place in cases of angoma by increasing fibrosis.

may adhere early in its development to the periosteum. Diagnosis is easy at first but difficult later. Methodical palpation and the roentgenogram provide help. Langhans described a periosteal angioma. It contained angiomas which produced crepitation mistaken for that of rice bodies.

Other tumors of the tendon sheaths such as myelomata, lipomata, fibromata, chondromata and sarcomata, are to be differentiated if possible.

Myelomata of tendon sheaths are by far the most common and important. Journeaux in 1913 collected 54 cases of this type from a series of 93 tendon sheath tumors. The German authors call them xanthomata, xanthosarcomata and giant cell sarcomata. The disease occurs more often in the upper extremity, more often in males and more often in the fingers and palm of the hand than in the forearm. The lower extremity may be involved. The tumor may arise at any age from 6 to 80 years, most frequently between 10 and 40 years. The duration of development has varied from 3 weeks to 70 years, with an average of 1 to 4 years. The tumors on the forearm are most malignant, while those on the fingers and palm are much more benign (Krogus, Rosenthal).

In Journeaux's series recurrences were noted in 21 cases of which 6 cases showed metastases to liver, lungs, etc. Rosenthal reported 71 cases in 1909 with 15 recurrences. It is interesting to note that many observers have recorded the presence of skin xanthomata and a high cholesterolin content in the blood in this disease. The latter has been invoked as a causal factor (Hoessler, Pincus and Pick, Pringsheim). Hartert believes that myelomata of tendon sheaths are different from myelomata of bone while Ily has reported a case of simultaneous bony and tendon myelomatous involvement. Myelomata are apparently encapsulated, often lobulated, and moderately firm or elastic. The microscopic picture presents a characteristic triad.

Giant cells or myeloplaxes first described by Heurteux, are always present and contain a variable number of nuclei. In the tumors of the forearm, they may be difficult to find. Lipoid cells, first described by Dor in 1898, are

large, vesicular, and bright. The nuclei are round or oval, often eccentric. There is much fat in the cell which doubly refracts and stains with Sudan III. This fat is the cholesterol ester of a fatty acid. Blood pigment, either extracellular or intracellular, giving the Prussian blue reaction for hemosiderin, is regularly found.

Lipomata of tendon sheaths are uncommon but 18 cases were reported up to 1922 by Strauss. There are two usual forms, the simple and the arborescent. The age at which onset occurs ranges from 2 to 34 years. The duration of symptoms is very long averaging 6 years. Symmetrical distribution and multiplicity of the lesions are occasionally observed. The lipoma may surround the tendon longitudinally and follow it to the tendon insertion, producing a cylindrical swelling which may crepitate. Another form attaches itself to the outside of the sheath by a pedicle. The site of predilection is the palm of the hand. Lipomata may destroy joints, bone and periosteum by direct infiltration. In a case of White a lipoma arising from the peroneal tendons destroyed the tarsal joints, necessitating a fusion operation.

Fibromata of tendon sheaths are uncommon and only 13 cases have been recorded. These tumors grow slowly, rarely reaching a large size. They are usually located on the flexor tendons of the palm. Ombredanne in 1907 reported 7 cases, none with sarcomatous elements. Hansmann is inclined to believe that in most so-called fibromata, if one seeks carefully on the edges of the tumor, one may see a different pathological picture. The fibrous tissue of the fibroma is only the end result in many. Case 4 (and in all probability the case of Schwartz) which grossly appeared to be a fibroma presented definite evidence of a hemangiomatous character at the periphery of the tumor.

Chondromata of tendon sheaths usually have a definite history of trauma. Only 9 cases have been recorded (Janik). These chondromata are small, hard and discrete and also may be lobulated. The tumor in each instance is composed of islets of hyaline cartilage interspersed among areas of fibrous tissue. Calcification and ossification may take

## MIXED TUMORS OF THE TONGUE AND SUBLINGUAL GLAND

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NEOPLASMS of complex structure, usually referred to as "mixed tumors," are not rarely encountered in the salivary glands, buccal mucosa, palate, lips, and orbit. They vary widely in histological appearance, but usually have two essential features in common: (1) epithelial elements arranged in solid masses, strands, or alveoli, and (2) "mesothelial" elements in the form of hyaline cartilage, mucous tissue or immature fibrous connective tissue. Often polyhedral or fusiform cells, similar in appearance to mesoblastic cells, are also found, but these may be traced through transition forms to origin from the epithelial elements present in the neoplasm.

Furthermore, in the regions mentioned there occurs a type of neoplasm characterized by cuboidal epithelial cells arranged in tubular structure and solid "cords." These tubules or cords are separated from one another by dense fibrous connective tissue septa in which there is often hyaline change. Neoplasms of this type closely resemble basal cell or adenocystic carcinoma. In the past most authors have regarded them as a variety of mixed tumor and have called them cylindromata. This term, however, is not specific. It was first introduced by Billroth and has since been applied to various unrelated types of neoplasms in which elongated masses of tumor cells are separated by connective tissue septa exhibiting hyaline change.

During the latter part of the nineteenth and the beginning of the twentieth centuries a stubborn controversy existed concerning the origin of mixed tumors. Volkmann propounded the theory of endothelial origin while Planteau, Mallassez, and others believed them to be carcinomata. Later Krompecher concluded that they were entirely of epithelial nature, even the cartilage and mucous interstitial tissue being derived from metaplasia of the epithelial cells. In summarizing the question Ewing states: "(1) The theory of endothelial origin of mixed

tumors has been disproved. (2) No single source of mixed tumors meets all requirements. Some are distinctly adenomatous and probably arise from acini and ducts of the gland in which they are well incorporated. Others are encapsulated or extraglandular and take the form of basal cell or adenocystic epithelioma. These probably arise from misplaced and occasionally embryonal portions of gland tissue. Bronchial elements may possibly be connected with this group. (3) The derivation of mucous tissue and cartilage from gland epithelium has been satisfactorily proved, and there is no necessity of including, in the originating tissue, any cartilaginous structures." In short, the carcinomatous nature of malignant mixed tumors has become generally recognized.

Because of the difference of opinion as to the true nature of mixed tumors in the early literature many other terms were applied to them, especially when they occur about the buccal cavity. Some of these were angiosarcoma, endothelial sarcoma, plexiform sarcoma, lymphangiosarcoma, myxosarcoma, and endothelioma. This, of course, has led to considerable confusion and false classification, for the same terms have been applied also to neoplasms which are definitely not mixed tumors.

## MIXED TUMORS OF THE SUBLINGUAL GLAND

Whereas much has been written concerning the salivary glands as a group, the literature contains but few specific references to neoplasms of the sublingual gland. Wagner observed a chondroma of this gland and Zeiss and Nicoladoni each an adenoma. Mixed tumors of the sublingual gland are very rare. A review of the literature has yielded only the two case reports which follow.

CASE 1. From Barth. The patient, a male, aged 67 years, first noticed a small mass the size of a lentil on the floor of the mouth beneath the tongue 2 years before he presented himself for medical attention. This gradually increased in size until it filled



We are indebted to the kindness and courtesy of Dr Arthur Steinler for the inclusion of the cases of the department to Dr H. I. Beyer for the use of Case 2 and to Dr C. H. Hansmann and the Department of Pathology of the University for their generous aid. The anatomical conception of the vaginal fistula as referred to in the mention of the lateral compartment of the leg the popliteal space and the forearm is that of Dr H. I. Steinert of the Department of Anatomy.

## BIBLIOGRAPHY

- 1 ANDREWS C. LINCOLN The rational treatment of hemangiomas and lymphangiomas *Acta Radiol* 1922, VIII 1-41
- 2 ARON Tumor of peroneus longus *Annalist* 1948 II 381
- 3 BAHR EDWIN VON Zur Behandlung der Angiome Heilberg J Harnig 1866
- 4 BARBER A Teninitis achilles arthritica *Zentralbl f. Chir* 1906 No 1
- 5 BIANCHI A case of a cavernous angioma of the vastus internus muscle *Arch ital di chir* 1906 21
- 6 BARNES CLAUDE Note on a case of congenital hypertrophy of leg (diffuse venous nevus) *J Anat & Physiol* 1885 6 25 35
- 7 BENTON ST J D Tumors of tendon sheaths *Brit J Surg* 1921 25 469
- 8 CARR and BRIDG A study of ganglion with special reference to treatment *Surg Gynec & Obst* 1928 XXII 470
- 9 CHALVIN and KOLX Fibro-chondrome de la gaine tendineuse et de l'extenseur du quatrième orteil *Bull. Soc Anat de Par* XVII 75
- 10 CHIFFAULT A Les lésions trophiques des bourses séreuses et des synoviales tendineuses *Arch de méd de Bucarest* 189, II 20
- 11 CHRISTOPHER A giant cell sarcoma apparently arising from the aponeurosis of the forearm *J Am M Ass* 1926 LXXVII 167
- 12 CRUVEILLIER JEAN *Anat path du corps humain* Vol 2 Book 30 plate 5 1835 42
- 13 CUNNINGHAM Text book of Anatomy 1922 5th ed
- 14 DELAGENIÈRE H Angiome cavernaux de l'avant bras droit *Arch prov de chir* 1894 III 218
- 15 ELLER J J The treatment of birthmarks by physical agents *Med J & Rec* 1926 November
- 16 ELY L W Giant cell growth of bone and tendon sheath *Ann Surg* 1918 LXVIII 426
- 17 ERING James Neoplastic Diseases 3d ed Philadelphia and London W B Saunders Company 1914
- 18 FALDI G Lympho angio endothelioma of tendon sheath *Chir org d movimento* 1928 VII 417
- 19 GANCOLPHIE A Angiome profonde peritendineuse simulant un kyste à grains tumeurs des gâmes tendineuses des extenseurs *Lyon méd* 1896 VII 578
- 20 HANSMANN G H Personal communication
- 21 HARTERT W Zur Kenntnis der pigmentierten riesenzellenhaltigen xanthosarkome *Beitr z klin Chir* 1913 LXXIV 526
- 22 HOESLER H Ueber Xanthome der Haut und der Sehnen *Beitr z klin Chir* 1914 21 168
- 23 JANNX Alfred Tumors of tendon sheaths. *Ann Surg* 1927 LXXV 897
- 24 JOLKWER W I Ein seltener Fall von Cystendothelium der Sehne *Zentralbl f Chir* 1906 III 1751
- 25 KEEN W W Surgery—Its Principles and Practice Philadelphia W B Saunders Co 1912
- 26 KNOTT T S Rare lesion of tendon. *Nederland Tijdschr v Geneesk* 1927 LXII 1332
- 27 KROCHET A Zur Kenntnis der sog Xanthosarkome etc *Acta chirurg* 1922-3 IV 363
- 28 Idem. Xanthosarcomas of tendon sheaths *Folia f. k. Hannt* 1922 LVII
- 29 LANDOUZ I and RATO M Beitr z klin Chir 1920 22
- 30 MARKOE T W Sarcoma of synovial sheaths *Med News* 1884 XIV 464
- 31 MAVER LE Tendoniran plantation *Surg Gynec & Obst* 1916 XXII 18
- 32 MCWHORTER J F and WEEKS C Multiple xanthomata of tendons *Surg Gynec & Obst* 1912 199
- 33 MICHAEL JOSEPH An article on bursæ (in preparation)
- 34 MONDRI H and HURT P Angiomes musculaires. *J de chir* 1923 VII 423
- 35 OLFERS-SHAW R Giant cell tumors of tendon associated with xanthelasma *Brit J Surg* 1913 2 467
- 36 OGDON R B Angioma of the knee joint *Surg Clin. America* 1921 I 681
- 37 PINCKEL A and PICKL K Zur Struktur und Genese der symptomatischen Xanthom *Deutsche med. Wchnschr* 1908 XXXII 146
- 38 PRINGSHEIM J Darstellung und chemische Beschaffenheit der Xanthomsubstanz *Deutsche med. Wchnschr* 1908 No 49 2144
- 39 RIDER FRANCIS Remarks on the treatment of cavernous and plexiform angioma *Illinois M J* 1917 XXVII 387
- 40 RICHER M *Bull Soc de chir de Par* 1860 p 69
- 41 ROSENTHAL A Zur Kenntnis der Sehnenscheiden sarkome *Beitr z klin Chir* LVII 577
- 42 RIGGLES H F Calcification in angiomas *Am J Roentgen* 1919 VI 222
- 43 SCHWARTZ Ein Fall von fibromatöser Verdrickung der Achillessehne *München med Wchnschr* 1908 p 2235
- 44 STEWART M J and FLINT F R Observations on the myeloid tumors of tendon sheaths *Brit J Surg* 1915 II 90
- 45 STEWART S F and BRITTON M E Motor significance of hemangioma *Surg Gynec & Obst* 1914 XXIV 307
- 46 STREUBER A Lipoma of tendon sheaths *Surg Gynec & Obst* 1922 XXII 167
- 47 THORN JULIUS Ueber die Entstehung der Ganglion *Arch f klin Chir* II 503
- 48 TOURENAUX J P Le Diagnostic du tumeur malignes des gâmes tendineuses *Progrès méd* 1910 p 225
- 49 WEIL S Ueber peritendineöse Angiome *Beitr z klin Chir* 1913-14 LXXVIII 56
- 50 WHITE J K Arborent lipomata of tendon sheath *Surg Gynec & Obst* 1914 XXVIII 489



Fig. 1. Case 3. E. H. D. Large fistulous opening in right mandibular region and neck due to erosion by malignant mixed tumor type cylindroma developing originally in right sublingual gland.

floor of the mouth, the right half of the mandible, the soft parts of the mental, submental, and right submandibular regions up to the level of the hyoid bone with exposure of a part of the left half of the mandible and the upper surface of the hyoid bone. Deformity of the entrance of the larynx and marked oedema of the mucosa. Extensive metastases into both lungs, particularly the right with umbilication of the subpleural nodules and implantation metastases on the parietal pleura.

Microscopic studies. 1. Sections were cut from paraffin blocks of tissue (Zenker's solution fixation and Ehrlich's hematoxylin and eosin stain) removed at operation in 1920. These blocks, sections of which are shown in Figs. 2 and 3, were lent by Dr. R. R. Linsley. The sublingual gland was seen to be invaded by a neoplastic growth composed of tubular structures of various sizes lined by two layers of cuboidal epithelial cells. The cells of the inner layer were smaller than those of the outer layer. The nuclei were rounded and hyperchromatic, the amount of cytoplasm small. The individual tubules were separated by septa of dense collagenic tissue which in places exhibited hyaline change. In many instances several tubules were closely applied to one another without intervening fibrous tissue. The lumina of the tubules were for the most part empty, but some contained finely granular debris or large eosinophilic disc-shaped masses resembling concretions. In places there were large areas of dense collagenic tissue exhibiting areas of hyaline change and in which were scattered a few isolated tubular structures. No mitotic figures were found in the neoplastic cells in sections examined.

2. Tissue (permanent preparation of frozen section and hematoxylin and eosin stain) removed at biopsy June 3, 1927, was examined by Dr. H. Hartwell of the Massachusetts General Hospital, whose



Fig. 2. Case 3. E. H. D. Section from mixed tumor of right sublingual gland removed in 1920. Neoplasm is composed of tubular structures separated by connective tissue septa in which there is hyaline change. A large area of dense connective tissue in which there is hyaline change is also present.  $\times 65$ .

report follows: the section (Fig. 4) was taken from a tiny fragment of tissue showing on microscopic examination a structure of clusters of small inactive epithelial cells forming tubule-like structures in a degenerative fibrous connective tissue stroma. The cells resemble those of basal cell carcinoma and the tubules suggest the cylindrical structure seen in cylindromata. The growth resembles the mixed tumor or cylindromata of the salivary gland and is of low degree malignancy.

3. Sections (alcohol formal fixation and Ehrlich's hematoxylin and eosin stain) from the ulcerated area at the base of tongue (Fig. 5) removed January 15, 1929, the day before death, showed the crater of the ulcer to be composed of a very narrow zone of heavily infiltrated oedematous fibrous connective tissue. The margins of the ulcer were considerably undermined. Scattered throughout the deeper portions of the section, on each side of and just beneath the crater of the ulcer, were many small tubular structures whose walls were composed of one or two layers of cuboidal or polyhedral epithelial cells with rounded hyperchromatic nuclei and a small amount of cytoplasm. In these cells an occasional mitotic figure was seen. Not infrequently a structure which consisted of several tubules, closely applied to one another without

the entire left side of the floor of the mouth. The tumor mass within the mouth was not ten centimeters in diameter which was pointed to the right was always painful. Next in the tongue increased the discomfort still was grateful recovery took place and there was no recurrence several months after operation when the tumor was removed and it was found to include the entire sublingual gland. The histopathological diagnosis was lymphangiosarcoma. From the description and illustrations, however, the true nature of the neoplasm is seen to be a mixed tumor. (Heinecke's case in this journal).

CASE 2. From Heinecke and Hoeschel. The patient a male aged 35 years complained of a small mass in the region of the right sublingual gland 14 years duration. There was no pain but medical consultation was sought because of the gradual increase in the size of the swelling. In the previous 6 months on examination the tumor in the region of the right sublingual gland was found to extend from the mandible anteriorly to the base of the tongue posteriorly but not into this organ. The mass was firm encapsulated not tender and was a slowly progressive swelling. The overlying mucosa was slightly injected. No enlarged regional lymph nodes were found. At operation the tumor was easily shelled out and partly it remained free from recurrence for several months. The histopathological diagnosis was cylindroma (benign of the sublingual gland).

In addition to these observations, others must be mentioned. (1) Heinecke observed a mixed tumor in the floor of the mouth (*Mundboden*) which was removed without recurrence and (2) Ribbert described a malignant cylindroma in the same location with metastases to the peritoneum. In the absence of specific descriptions as to the relations of these tumors to the sublingual gland they cannot be regarded as neoplasms of the latter.

In the case report which follows not only is there an instance of a mixed tumor (cylindroma) of the sublingual gland, a condition which, as has been shown, is extremely rare, but also there is an example of a mixed tumor of 19 years' duration which became malignant in the last several years and has caused extensive local destruction and producing metastases. Fortunate circumstances have enabled the writer to procure for histological study tissue removed in 1910 at the onset of the process and in 1927, when a biopsy was performed upon the lesion.

CASE 3. I. H. D. cachectic white female 60 years of age, a physician was admitted to The University Clinics January 11, 1929 because of marked

weakness and inability to speak and to swallow due to a large defect in the right side of the mandible with a large fistulous opening. In 1910 the patient had first noted a small growth in the right sublingual gland. This was removed under local anesthesia. The details of the history were not available from that time until 1922 when the patient noted swelling on the internal surface of the body of the mandible on the right side. This swelling was complicated by an abscessed tooth in the same region. Incision and drainage of the abscess afforded relief but the wound did not completely heal. In 1923 a pathological fracture occurred in the right side of the mandible in the region of the first molar. The wound made for incision of the abscess continued to discharge and pieces of bone were extruded at intervals. In 1927 a biopsy in the region of the wound was performed and an opening was made in the floor of the mouth. The diagnosis from biopsy was mixed tumor—so-called cylindroma. Roentgen ray therapy was employed at that time. In 1927 a roentgenogram of the mandible showed erosion of the right side of the body of the ramus. The personal and family histories were irrelevant.

Physical examination revealed a markedly cachectic elderly white female unable to speak except for a few guttural sounds. The lips could be separated for a distance of only 2.5 centimeters but this caused much pain. The few remaining teeth were covered with much foul caseous material. In the right mandibular region and extending on to the neck was a large irregular fistulous opening about 6 centimeters in diameter communicating with the mouth and pharynx. In the center of the cavity a whitish oval mass was seen. The upper part of the epiglottis also was visible through the opening and was seen to be eroded. Physical examination was otherwise essentially negative as far as could be determined except for the rapid heart rate (120 per minute) and slight blowing diastolic murmur over the apex. The blood pressure was 84-55 mm. Hg. was negative. The white blood cell count was 10,000 and the Wassermann and Kahn tests were negative. Roentgenograms of the skull showed absence of the right side of the body of the mandible to the ramus.

Clinical diagnosis slowly growing malignant tumor probably of sublingual gland.

A Wittel gastrostomy was performed (Dr. I. R. Dragstedt) for the purpose of nourishing the patient. Local anesthesia was used. Milk and glucose solutions were introduced into the stomach and well tolerated. The following day the remains of the tongue were found protruding from the large opening in the form of a round whitish firm mass about 4 centimeters in diameter attached by a slender fibrous cord like pedicle. This was severed and the tongue removed. The next morning its spines suddenly developed and 52 hours later the patient died.

Necropsy was performed by Dr. Bela Halpert. The abstract of his anatomical diagnosis follows: "Carcinoma of the mucosa of the mouth with destruction of the apex and corpus of the tongue the



Fig 1. Case 3. E. H. D. Large fistulous opening in right mandibular region and neck due to erosion by malignant mixed tumor type cylindroma developing originally in right sublingual gland

floor of the mouth the right half of the mandible the soft parts of the mental submental and right submandibular regions up to the level of the hyoid bone with exposure of a part of the left half of the mandible and the upper surface of the hyoid bone. Deformity of the entrance of the larynx and marked oedema of the mucosa. Extensive metastases into both lungs particularly the right with umbilication of the subpleural nodules and implantation metastases on the parietal pleura.

Microscopic studies. 1 Sections were cut from paraffin blocks of tissue (Zenker's solution fixation and Ehrlich's hematoxylin and eosin stain) removed at operation in 1910. These blocks sections of which are shown in Figs 2 and 3 were lent by Dr R. R. Bensley. The sublingual gland was seen to be invaded by a neoplastic growth composed of tubular structures of various sizes lined by two layers of cuboidal epithelial cells. The cells of the inner layer were smaller than those of the outer layer. The nuclei were rounded and hyperchromatic, the amount of cytoplasm small. The individual tubules were separated by septa of dense collagenous tissue which in places exhibited hyaline change. In many instances several tubules were closely applied to one another without intervening fibrous tissue. The lumina of the tubules were for the most part empty but some contained finely granular debris or large eosinophilic disc shaped masses resembling concretions. In places there were large areas of dense collagenous tissue exhibiting areas of hyaline change and in which were scattered a few isolated tubular structures. No mitotic figures were found in the neoplastic cells in sections examined.

2 Tissue (permanent preparation of frozen section and hematoxylin and eosin stain) removed at biopsy June 3, 1927 was examined by Dr H. Hartwell of the Massachusetts General Hospital whose

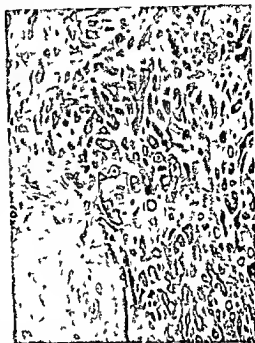


Fig 2. Case 3. E. H. D. Section from mixed tumor of right sublingual gland removed in 1910. Neoplasm is composed of tubular structures separated by connective tissue septa in which there is hyaline change. A large area of dense connective tissue in which there is hyaline change is also present. X65

report follows: the section (Fig 4) was taken from a 'tiny fragment of tissue showing on microscopic examination a structure of clusters of small inactive epithelial cells forming tubule like structures in a degenerative fibrous connective tissue stroma. The cells resemble those of basal cell carcinoma and the tubules suggest the cylindrical structure seen in cylindromata. The growth resembles the mixed tumor or cylindromata of the salivary gland and is of low degree malignancy.

3 Sections (alcohol formal fixation and Ehrlich's hematoxylin and eosin stain) from the ulcerated area at the base of tongue (Fig 5) removed January 15, 1929 the day before death showed the crater of the ulcer to be composed of a very narrow zone of heavily infiltrated oedematous fibrous connective tissue. The margins of the ulcer were considerably undermined. Scattered throughout the deeper portions of the section on each side of and just beneath the crater of the ulcer were many small tubular structures whose walls were composed of one or two layers of cuboidal or polyhedral epithelial cells with rounded, hyperchromatic nuclei and a small amount of cytoplasm. In these cells an occasional mitotic figure was seen. Not infrequently a structure which consisted of several tubules closely applied to one another without

the entire left side of the floor of the mouth. The tumor mass within the mouth was not tender but the tongue which was pushed to the right was always painful. Heat on the tongue in raised the discomfort could was grateful. Recovery took place and there was no recurrence several months after operation when the tumor was removed in 1917 and was found to include the entire sublingual gland. The histopathological diagnosis was lymphangioma sarcoma from the description and illustrations; however the true nature of the neoplasm is seen to be a mixed tumor. (Heinecke concurs in this opinion.)

CASE 2 From Heully and Boeckel. The patient a male aged 39 years complained of a small mass in the region of the right sublingual gland of 4 years duration. There was no pain but medical consultation was sought because of the gradual increase in the size of the mass during the previous 8 months. On examination the tumor in the region of the right sublingual gland was found to extend from the mandible anteriorly to the base of the tongue posteriorly but not into this organ. The mass was firm encapsulated not tender and was easily movable on surrounding tissues. The overlying mucosa was slightly injected. No enlarged regional lymph nodes were found. At operation the tumor was easily shelled out and patient remained free from recurrence for several months. The histopathological diagnosis was cylindroma (benign) of the sublingual gland.

In addition to these observations, others must be mentioned. (1) Heinecke observed a mixed tumor in the floor of the mouth (*Mundboden*) which was removed without recurrence, and (2) Ribbert described a malignant cylindroma in the same location with metastases to the peritoneum. In the absence of specific descriptions as to the relations of these tumors to the sublingual gland they cannot be regarded as neoplasms of the latter.

In the case report which follows not only is there an instance of a mixed tumor (cylindroma) of the sublingual gland a condition which, as has been shown, is extremely rare but also there is an example of a mixed tumor of 19 years' duration which became malignant in the last several years and has caused extensive local destruction and producing metastases. Fortunate circumstances have enabled the writer to procure for histological study tissue removed in 1910, at the onset of the process, and in 1917, when a biopsy was performed upon the lesion.

CASE 3 E. H. D. cachectic white female 60 years of age a physician was admitted to The University Clinics January 11, 1929 because of marked

weakness and inability to speak and to swallow due to a large defect in the right side of the mandible with a large fistulous opening. In 1910 the patient had first noted a small growth in the right sublingual gland. This was removed under local anesthesia. The details of the history were not available from that time until 1922 when the patient noted swelling on the internal surface of the body of the mandible on the right side. This swelling was complicated by an abscessed tooth in the same region. Incision and drainage of the abscess afforded relief but the wound did not completely heal. In 1923 a pathological fracture occurred in the right side of the mandible in the region of the first molar. The wound made for incision of the abscess continued to discharge and pieces of bone were extruded at intervals. In 1927 a biopsy in the region of the wound was performed and an opening was made in the floor of the mouth. The diagnosis from biopsy was mixed tumor—so called cylindroma. Roentgen ray therapy was employed at that time. In 1927, a roentgenogram of the mandible showed erosion of the right side of the body to the ramus. The personal and family histories were irrelevant.

Physical examination revealed a markedly cachectic elderly white female unable to speak except for a few guttural sounds. The lips could be separated for a distance of only 1.5 centimeters but this caused much pain. The few remaining teeth were covered with much foul caseous material. In the right mandibular region and extending on to the neck was a large irregular fistulous opening about 6 centimeters in diameter communicating with the mouth and pharynx. In the center of the cavity a whitish oval mass was seen. The upper part of the epiglottis also was visible through the opening and was seen to be eroded. Physical examination was otherwise essentially negative as far as could be determined except for the rapid heart rate (110 per minute) and slight blowing diastolic murmur over the apex. The blood pressure was 84-50 mm. Hg. analysis was negative. The white blood cell count was 10,000 and the Wassermann and Kahn tests were negative. Roentgenogram of the skull showed absence of the right side of the body of the mandible to the ramus.

Clinical diagnosis slowly growing malignant tumor probably of sublingual gland.

A Witzel gastrostomy was performed (Dr. L. R. Drigstedt) for the purpose of nourishing the patient. Local anesthesia was used. Milk and glucose solutions were introduced into the stomach and well tolerated. The following day the remains of the tongue were found protruding from the large opening in the form of a round whitish firm mass about 4 centimeters in diameter attached by a slender fibrous cord like pedicle. This was severed and the tongue removed. The next morning dyspnea suddenly developed and 1/2 hour later the patient died.

Necropsy was performed by Dr. Bela Halpert. The abstract of his anatomical diagnosis follows: Carcinoma of the mucosa of the mouth with destruction of the apex and corpus of the tongue the



Fig 4 Case 3 E H D Section from biopsy of wound in mouth taken in 1927. Tubular structures scattered in dense fibrous connective tissue  $\times 65$



Fig 5 Case 3 E H D Section through ulcer at base of tongue (1920) showing floor of ulcer beneath which are many tubular structures  $\times 65$

of the many other vague terms used in the older literature was employed. In each instance, however, the writer has carefully studied the descriptions and available illustrations and those which in his opinion were undoubtedly mixed tumors are included in the following series:

**CASE 4.** From Luecke. The patient a male aged 36 years had a slowly growing tumor in the left side of the base of the tongue. The tumor though painless was the size of a large walnut. It had been present for 7 years and interfered with deglutition. Excision was done. No diagnosis was made.

This was a cylindroma.

**CASE 5.** From Godlee. The patient a female aged 24 years presented an ulcerated tumor with calcareous nodule in the center on the under surface of the tip of the tongue. The tumor had appeared 5 weeks earlier. Excision was done and there was no recurrence. The histopathological diagnosis was adenocarcinoma or mixed cell sarcoma.

**CASE 6.** From Santesson. The patient was an adult with a slowly growing infiltrating tumor in the left half of the tongue. First notice of the tumor was taken 3 years before. There was slight pain and at times considerable hemorrhage. Metastases to the parotid gland seemed probable. The tumor was excised. The histopathological diagnosis was sarcoma, pleomorphic hyaline.

**CASE 7.** From Ewald. The patient was a female aged 36 years with an infiltrating tumor in the right side of the tongue near the base. The character of her voice had changed and deglutition was difficult. After excision there was local recurrence in 1 year followed by a second operation. The tumor recurred again 2 years later with metastases to the pharynx, the floor of the mouth, and the cervical lymph nodes. The histopathological diagnosis was cylindroma (mixed tumor).

**CASE 8.** From Mercier. The patient a male aged 26 years had had a slowly growing tumor of the anterior portion of the tongue for 8 years. Excision was done and there was no recurrence. The histopathological diagnosis was large mixed cell sarcoma.

**CASE 9.** From Summers. The patient was a female 3 years of age. She had a tumor at the base of the tongue to the left of the midline which was the size of a walnut. Difficulty in deglutition and the excessive secretion of saliva were present and there had been hemoptysis on two occasions. Excision was done and the histopathological diagnosis was endothelioma or adenoma. This tumor resembled the endotheliomata, i.e. mixed tumors of the salivary glands described by Volkmann.

**CASE 10.** From Van Kryger. The patient, a female aged 31 years had a tumor at the base of the tongue in the midline. The tumor which had appeared 7 years earlier was the size of half a cherry. It was excised and the histopathological diagnosis made was endothelioma.



Fig. 3. Case 1. I. H. D. High power photomicrograph of portion of sublingual gland tumor removed in 1910. Structures are present which appear to be composed of several tubules closely applied to one another without intervening fibrous tissue.  $\times 125$ .

intervening interstitial tissue was found but in general the individual tubules were separated by narrow strands of edematous fibrous connective tissue in which there was moderate to dense infiltration by leucocytes.

4. Sections (fixation and stain as above) from the lung (Fig. 6) show just beneath the pleura a round neoplastic mass composed of tubular structures similar to those just described. Many of these tubules were larger than those seen in the previous studies and the two layers of cuboidal cells lining them were in many places replaced by a narrow wall of closely packed polyhedral cells with small oval nuclei. Occasional mitotic figures were seen in the epithelial cells. The lumina for the most part, were empty but a number of them contained granular debris and a few endothelial leucocytes. In some there was reticulated material or large smooth oval lightly staining masses resembling concretions. This neoplastic growth was not separated from the lung parenchyma, which was normal, by a definite capsule nor was there any leucocytic infiltration or exudation in the alveoli immediately surrounding it.

Attention must be called to the fact that in all these sections made from tissue removed at intervals over a period of 19 years the character of the epithelial elements is essentially unchanged.

From a study of the sections and the clinical history, there would appear to be little doubt that the neoplasm was benign at the onset of development, but that it became malignant in the last several years causing much local destruction and metastasizing to the lung and pleura. This behavior, i. e., a long or short period of benign development preceding malignant degeneration, is characteristic of mixed tumors—particularly those of the parotid—which become malignant. The extensive and progressive local destruction present in the case just described is also characteristic of basal cell carcinoma, the type of neoplasm which the cylindroma (mixed tumor) so closely resembles.

By far the greatest number of mixed tumors occurring in the salivary glands are found in the parotid. In a series of 360 mixed tumors of the salivary glands collected from the literature and studied by Heinecke, 78 or 80 per cent were found in this gland. The reason for this is not at all clear. Trauma is decidedly not a factor since the sublingual glands are much more exposed than either the parotid or submaxillary. The parotid is purely a serous gland. The submaxillary is a mixed gland but predominantly serous while the sublingual is also mixed but predominantly mucous. What significance, if any, from the standpoint of etiology of mixed tumors, this difference in histological structure has cannot of course be definitely stated.

Of the 3 cases summarized above one was malignant making the incidence 33 per cent. This is approximately the same as for the much greater series occurring in the parotid and submaxillary glands which according to various authors, is between 25 and 30 per cent.

#### MIXED TUMORS OF THE TONGUE

Mixed tumor of the tongue also constitutes a rare condition. Rosenbergs in a review of the literature on neoplasms of the tongue, does not mention mixed tumors. Wilms in an extensive treatise on mixed tumors in general, does not cite an instance of one which developed in the tongue. A few cases however have been recorded. In the majority of instances the diagnosis of mixed tumor was not made in the report of the case. Instead one



Fig. 4 Case 3 E H D Section from biopsy of wound in mouth taken in 1927. Tubular structures scattered in dense fibrous connective tissue  $\times 65$ .

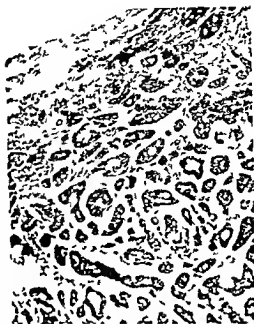


Fig. 5 Case 3 L H D Section through ulcer at base of tongue (19 9) showing floor of ulcer beneath which are many tubular structures  $\times 65$ .

of the many other vague terms used in the older literature was employed. In each instance, however, the writer has carefully studied the descriptions and available illustrations and those which in his opinion were undoubtedly mixed tumors are included in the following series:

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This was a cylindroma.

**CASE 5.** From Godlee. The patient a female aged 24 years presented an ulcerated tumor with calcareous nodule in the center on the under surface of the tip of the tongue. The tumor had appeared 5 weeks earlier. Excision was done and there was no recurrence. The histopathological diagnosis was adenocarcinoma or mixed cell sarcoma.

**CASE 6.** From Santesson. The patient was an adult with a slowly growing infiltrating tumor in the left half of the tongue. First notice of the tumor was taken 3 years before. There was slight pain and at times considerable hemorrhage. Metastases to the parotid gland seemed probable. The tumor was excised. The histopathological diagnosis was sarcoma, pleomorphic hyalimum.

**CASE 7.** From Fwald. The patient was a female aged 36 years, with an infiltrating tumor in the right side of the tongue near the base. The character of her voice had changed and deglutition was difficult. After excision there was local recurrence in 1 year followed by a second operation. The tumor recurred again 2 years later with metastases to the pharynx, the floor of the mouth and the cervical lymph nodes. The histopathological diagnosis was cylindroma (mixed tumor).

**CASE 8.** From Mercier. The patient a male, aged 26 years had had a slowly growing tumor of the anterior portion of the tongue for 8 years. Excision was done and there was no recurrence. The histopathological diagnosis was large mixed cell sarcoma.

**CASE 9.** From Summers. The patient was a female 37 years of age. She had a tumor, at the base of the tongue to the left of the midline which was the size of a walnut. Difficulty in deglutition and the excessive secretion of saliva were present and there had been hæmoptysis on two occasions. Excision was done and the histopathological diagnosis was endothelioma or adenoma. This tumor resembled the endotheliomata, i.e. mixed tumors of the salivary glands described by Volkmann.

**CASE 10.** From Van Kriger. The patient a female aged 31 years had a tumor at the base of the tongue in the midline. The tumor which had appeared 2 years earlier was the size of half a cherry. It was excised and the histopathological diagnosis made was endothelioma.





Fig. 3. Case 1. E. H. D. High power photomicrograph of portion of sublingual gland tumor removed in 1910. Structures are present which appear to be composed of several tubules closely applied to one another without intervening fibrous tissue.  $\times 225$ .

intervening interstitial tissue was found but in general the individual tubules were separated by narrow strands of edematous fibrous connective tissue in which there was moderate to dense infiltration by leucocytes.

4. Sections (fixation and stain as above) from the lung (Fig. 6) show just beneath the pleura a round neoplastic mass composed of tubular structures similar to those just described. Many of these tubules were larger than those seen in the previous studies and the two layers of cuboidal cells lining them were in many places replaced by a narrow wall of closely packed polyhedral cells with small oval nuclei. Occasional mitotic figures were seen in the epithelial cells. The lumina for the most part were empty but a number of them contained granular debris and a few endothelial leucocytes. In some there was reticulated material or large smooth oval lightly staining masses resembling concretions. This neoplastic growth was not separated from the lung parenchyma which was normal by a definite capsule nor was there any leucocytic infiltration or exudation in the alveoli immediately surrounding it.

Attention must be called to the fact that in all these sections made from tissue removed at intervals over a period of 10 years the character of the epithelial elements is essentially unchanged.

From a study of the sections and the clinical history, there would appear to be little doubt that the neoplasm was benign at the onset of development, but that it became malignant in the last several years causing much local destruction and metastasizing to the lungs and pleura. This behavior, i. e., a long or short period of benign development preceding a malignant degeneration, is characteristic of mixed tumors—particularly those of the parotid—which become malignant. The extensive and progressive local destruction present in the case just described is also characteristic of basal cell carcinoma, the type of neoplasm which the cylindroma (mixed tumor) so closely resembles.

By far the greatest number of mixed tumors occurring in the salivary glands are found in the parotid. In a series of 360 mixed tumors of the salivary glands collected from the literature and studied by Heinecke, 50 or 80 per cent were found in this gland. The reason for this is not at all clear. Trauma is decidedly not a factor since the sublingual glands are much more exposed than either the parotid or submaxillary. The parotid is purely a serous gland. The submaxillary is a mixed gland but predominantly serous while the sublingual is also mixed but predominantly mucous. What significance, if any, from the standpoint of etiology of mixed tumors this difference in histological structure has cannot of course be definitely stated.

Of the 3 cases summarized above one was malignant making the incidence 3.3 per cent. This is approximately the same as for the much greater series occurring in the parotid and submaxillary glands which according to various authors is between 2.5 and 30 per cent.

#### MIXED TUMORS OF THE TONGUE

Mixed tumor of the tongue also constitutes a rare condition. Rosenber, in a review of the literature on neoplasms of the tongue, does not mention mixed tumors. Wilms in an extensive treatise on mixed tumors in general does not cite an instance of one which developed in the tongue. A few cases however, have been recorded. In the majority of instances the diagnosis of mixed tumor was not made in the report of the case. Instead, one



Fig 7 Case 14 M B Section from mixed tumor in tongue showing papillary cystic structure and irregular masses of cells which resemble mesoblastic cells but which are in reality epithelial elements scattered in stroma  $\times 65$



Fig 8 Case 14 M B Section from metastasis of mixed tumor in large cervical lymph node showing primarily papillary cystic structures which vary greatly in size  $\times 65$

columnar epithelial cells arranged in small closely packed masses, anastomosing cords or lying in single layers about small oval or irregular alveolar spaces. These cells exhibited large round hyperchromatic nuclei and small amounts of eosinophilic homogeneous cytoplasm. In the superficial portion of the section were oval papillary cystic structures also, the cyst cavities being lined by low cuboidal or flattened epithelium resembling endothelium. The cystic spaces were nearly filled with papillomatous masses composed for the most part of closely packed columnar or polyhedral epithelial cells similar in appearance and arrangement to the cells described above.

Deeper in the section the interstitial tissue became very abundant and varied considerably in appearance. In places it was composed of closely packed fasciculi of collagenic fibers among which were thin compressed fibroblast nuclei. Elsewhere it consisted of a light bluish reticulated and vacuolated ground substance (perhaps mucous tissue) in which were scattered rounded wandering cells or fibroblasts with large rounded finely stippled nuclei. In these deeper portions of the section were also widely separated masses of columnar epithelial cells and irregularly shaped cells with rounded or oval nuclei and more abundant cytoplasm than in the epithelial cells previously described. These cells were arranged for the most part in large or small compact masses but when seen in groups of two or

three or even singly in the interstitial tissue they closely resembled mesothelial cells. Numerous transitional forms between this type of cell and the columnar epithelial cell could be seen.

Sections (fixation and stain as above) through the large lymph node removed from the cervical region (Fig 8) showed normal lymphoid parenchyma almost entirely replaced by a neoplastic growth consisting of papillary cystic structures varying considerably in size alternating with groups of small alveoli lined by a single layer of low columnar epithelial cells. Between some of these alveoli were small masses of polyhedral or fusiform cells closely resembling mesoblastic cells. The papillary cystic structures were similar in appearance to those described in the primary lesion above except that some reached a much greater size and in two or three instances the papillary mass completely filled the cystic space, compressing the lining epithelium. In the central part of the section the papillary cystic structures were widely separated by bands of edematous fibrous connective tissue. Nearer the periphery the stroma was less abundant. In these sections the stroma did not possess the mucous character seen in places in the primary lesion.

*Subsequent history* The patient was seen on July 15, 1929. The wound in the neck was completely healed. There were no palpable masses present in this region. Deglutition and speech were



Fig 6 Case 3. F. H. D. Section through margin of metastasis of cylindroma in lung, showing abrupt change from neoplastic to lung tissue. Pulmonary alveolar bordering metastasis are normal.  $\times 65$

This was in reality a cylindroma type of mixed tumor in the interstitial tissue of which were epithelial cells morphologically resembling mesoblastic cells.

**CASE 11.** From Scholle. The patient who was a male aged 78 years had an encapsulated tumor at the base of his tongue 1 centimeter in diameter found in routine examination at autopsy. He died following a cranial operation for trifacial neuralgia. The histopathological diagnosis was mixed tumor.

**CASE 12.** From Quenu. The patient a female 50 years of age exhibited a tumor at the base of the tongue half the size of a cherry, encapsulated and movable on the deep tissues which was of several months duration. There was no functional disturbance. Excision was done and the histopathological diagnosis was cylindroma (benign).

**CASE 13.** From Preusse. The patient who was a male aged 50 years had an ulcerating tumor the size of a hazelnut on the left margin of the tongue. It had appeared only a few months before. Excision of the tumor and the regional lymph nodes was performed. The histopathological diagnosis made was cylindroma (no metastases).

**CASE 14.** M. B. a white female 66 years of age was admitted to The University Clinics February 17, 1929 complaining of a swelling of 3 years duration on the left side of the neck, and of "sore tongue" of 1 week's duration. The swelling was just below the angle of the mandible and when first noted was the

size of a bean." It had gradually become larger but had not interfered in any way with speech or deglutition. A week prior to admission the patient had developed a cold and at that time had noted a soreness in the tongue and in the mass in the left side of the neck. She then recalled that on 3 previous occasions when she had had colds the tongue and the mass in the neck had been sore. For the first time also 1 week prior to admission another mass was noted on the left margin of the posterior portion of the tongue. The personal and family histories were irrelevant.

Physical examination revealed a small elderly well developed and well nourished white female not acutely ill. Physical findings were essentially negative except for an oval firm slightly tender mass 4 centimeters long and 2 centimeters wide in the upper part of the left anterior cervical triangle over the anterior margin of the sternomastoid muscle. This mass was not attached to the overlying skin which appeared normal and was easily movable on the deeper tissues. On the left margin of the tongue anterior to the circumvallate papillae there was a firm whitish rounded area about 1.5 centimeters in diameter. The mucosa there was slightly raised and apparently intact although it felt rougher and was paler than the rest of the surface of the tongue. The firm area extended into the deeper tissues and gave the impression of an infiltrating lesion. The blood pressure was 140-70 the urine was negative the red blood cell count was 5,180,000 the white blood cell numbered 8,500 the hemoglobin was 80 per cent and the Wassermann and Kahn tests were negative. Roentgenograms of the chest showed the lungs and heart to be normal.

Clinical diagnosis carcinoma of the base of the tongue with metastases to the cervical lymph nodes.

On February 13, 1929 a biopsy was performed upon the lesion in the tongue and at the same time twelve gold radon seeds .093 millicurie each were embedded concentrically about the tumor. Diagnosis from the biopsy was mixed tumor (see below).

Operation was performed by Dr. D. B. Phemister 9 days later for removal of the mass in the upper left side of the neck. This was found to be one of several enlarged firm lymph nodes of the upper part of the deep cervical chain surrounding and closely adherent to the internal jugular vein and to the lower portion of the parotid gland. To remove these lymph nodes it was necessary to excise a segment of the internal jugular vein. The left submaxillary gland and lymph nodes also were removed. Convalescence was uneventful and the patient was discharged 11 days later.

**Microscopic studies.** 1. Sections (alcohol formalin fixation and Ehrlich's hematoxylin and eosin stain) of tissue removed from tongue at biopsy (Fig 7) showed along the margin corresponding to the surface of the tongue no stratified squamous epithelium instead there was a very thin compressed band of fibrous connective tissue. Immediately beneath this was a rather broad zone of cuboidal to low

ported cases of mixed tumor in the sublingual gland and 10 in the tongue

2 A case of mixed tumor, type cylindroma, of the sublingual gland is reported. This neoplasm was present for 19 years. Apparently benign at first, it finally became malignant, causing extensive local destruction and producing metastases in the lungs and pleura

3 A case of slowly growing malignant mixed tumor of the tongue of several years' duration, with metastases to the regional lymph nodes, is reported. Combined surgical (excision) and radium therapy appears to have eradicated the process

BIBLIOGRAPHY

1 BARTH Beitr z path Anat u z allg Path 1896 xix 461  
2 BILLROTH T Untersuchungen ueber die Entwicklung der Blutgefasse Berlin 1836  
3 EWALD Cylindrome der Zunge Wien klin Wchnschr 1897 p 332  
4 EWING Neoplastic Diseases 3d ed Philadelphia W B Saunders Company 1915 p 775  
5 GODLEE Case report Tr Path soc Lond 1887 xxviii 346  
6 HEINECKE Die Geschwuelste der Speicheldruesen Ergebn d Chir u Orthop 1913 vi 39  
7 HEULLY and BOECKEL Une forme rare de tumeur des glandes salivaires (cylindrome de la glande subling) Rev de chir, 1911, xliii 468  
8 KROMPECHER Ueber die Beziehungen zwischen Epithel und Bindegewebe bei den Mischgeschwuelst

en der Haut und der Speicheldruesen und ueber das Entstehen der Karzinosarkome Beitr z path Anat u z allg Path 1908 xlii 51  
9 KREITNER Die Geschwuelste der Submaxillarspeicheldruese Beitr z klin Chir 1896 xvi 181  
10 LUCAS Ueber Geschwuelste mit hyaliner degeneration Arch f path Anat 1866 xxxv 53  
11 MALASSEZ Sur le cylindrome Arch de physiol norm et path 1883 iii  
12 MEYER Case report Rev méd de la Suisse Rom 1890  
13 NICOLADONI Adenom aus der Wange Deutsche Ztschr f Chir 1872 i 41  
14 PLANTEAC Contribution à l'étude des tumeurs du la parotide Thèse de doct Paris 1876  
15 PRELISSE Zylndrome der Zunge Beitr z klin Chir 1911 cxxii 355  
16 QUÉNU Cylindrome de la base de la langue Bull et mém Soc de chir de Par xiv 1910 xiv 00  
17 RIBBERT Geschwulstlehre Bonn Friedr. Cohen 1914 p 591  
18 ROSENBERG Die Geschwuelste des Zungengrundes Deutsche med Wchnschr 189 cclxxxi 311  
19 SANTE Quoted by Fwall  
20 SCHOLLE Eine Mischgeschwulst der Zungenbasis Leipzig 1904  
21 SUMMERS Case report West V Rev, 1901 vi 122  
22 VAN KRIGER Fine seltenere Geschwulstbildung in der zunge (Endotheliom) Festschr der Universitat Erlangen Heft 3 1901 p 243  
23 VOLAMANN K Ueber endotheliale Geschwuelste zugleich ein Beitrage zu den Speicheldruesen und Gaumentumoren Deutsche Ztschr f Chir, 1893, xli i  
24 WAGNER Angeborenes Enchondrom des Bodens der Mundbohle Arch f Heill 1861 ii 283  
25 WILMS Die Mischgeschwuelste Leipzig, Arthur George 1899  
26 WOOD Mixed tumors of the salivary glands Ann Surg 1904 xxxix 57 207  
7 ZEISEL Eine noch nicht beschriebene Geschwulst der Sublingualdruese Ost med Jahrb 197 1881

unimpaired. Examination of the tongue however, revealed a well defined raised oval, firm yellowish area about 1 centimeter in diameter at the site of the previous operation. In the center was a depressed puckered scar. There was no pain or soreness in the tongue and the increased firmness of the raised area was no doubt due to the fibrosis resulting from the action of the radon seeds. As an additional measure of precaution six more gold radon seeds of 1 millicurie each were embedded concentrically about the site of the lesion. Since this time there have been several severe attacks of pain in the tongue and neck for which deep roentgen ray therapy was given. There has been no pain since last October nor any evidence of recurrence of the neoplasm.

A very interesting feature of this last case is the fact that the metastases were noted long (3 years) before the primary lesion. Since the whole process was of slow development, it must be inferred that the primary lesion was present for perhaps at least 4 years and since malignant mixed tumors usually have a period of benign growth before malignant degeneration, it is possible that the primary tumor was present for a considerable length of time before its discovery.

The number of cases of mixed tumor in the tongue summarized is small but nevertheless permits analysis for comparison with the large series of mixed tumors of the salivary glands reviewed by Heinecke. Cases 4 to 14 of this series were adults, the youngest of whom was 24 and the oldest 78 years of age. Four patients or 36 per cent, were in the third decade, 6 were females, 5 were males, 3, or 28 per cent, were definitely malignant. In Heinecke's series (360 cases) the youngest patient was an infant born with parotid mixed tumor, the oldest was in the seventh decade. Thirty per cent of the cases were in the third decade. Males and females were equally affected. According to this author the exact incidence of malignancy in mixed tumors is difficult to determine since because of their complex structure a definite diagnosis of malignancy cannot be made from study of microscopic preparations alone. Kuettner in a series of 56 submaxillary mixed tumors states that 28 per cent were malignant and Wood, in a series reviewed from the literature states that about "25 per cent undergo changes which express themselves in a clinically malignant course." Thus, in behavior, mixed

tumors of the tongue resemble closely mixed tumors of the salivary glands.

The diagnosis of mixed tumor of the tongue is difficult clinically because of the rarity of the condition and because there is no constant clinical picture. As shown on physical examination these tumors may have all the characteristics of a slowly growing encapsulated benign neoplasm or may resemble malignant tumors with infiltration of surrounding tissue and metastases. The symptomatology of mixed tumor of the tongue is also extremely variable and depends upon the location of the tumor and its size. In some instances only its presence was noted by the patient on the other hand, pain impairment of speech and deglutition and even hemoptysis were the complaints.

Of the cases reported above 7 occurred at the base of the tongue. It is not uncommon to find in this region aberrant masses of thyroid tissue exhibiting immature structure or remnants of the thyroglossal duct. What relation if any these structures may have to the origin of mixed tumors in the tongue cannot be definitely stated. Furthermore there occur in the mucosa of the buccal cavity numerous small tubulo alveolar mucous and serous (salivary) glands. The possibility of origin of mixed tumors from these glands (glandulae linguales) which are also present in the tongue must be borne in mind.

The treatment of mixed tumors of the tongue in the cases reviewed was excision. Subsequent histories were not available in most of these reports. In the last case reported above radium therapy combined with excision of the primary lesion and metastases has afforded until the present at least satisfactory results. The facts that malignant mixed tumors do not as a rule grow very rapidly and that they tend to produce only regional metastases permit a more or less favorable prognosis for combined surgical and roentgen therapy in cases that have not progressed too far.

#### SUMMARY

1. Mixed tumors of the tongue and of the sublingual gland are very rare. In a review of the literature the author found but 2 re-

# SURGICAL STATISTICS

During the past 10 years great progress has been made in the surgical treatment of gastro intestinal diseases particularly of ulcers of the stomach and the duodenum. In place of posterior gastro enterostomy, the old type of operation for these ulcers, surgeons now use partial gastrectomy, a most radical operation, which involves the removal of a large part of the stomach and the ulcer bearing area. This affords a great opportunity for finding the exact location of the ulcer.

There have been many noted surgeons who have collected from their operations statistics concerning the position of ulcers in the pyloric region and the first part of the duodenum, but we shall mention only a few of these surgeons. Moynihan in his book, "Duodenal Ulcer," states that in at least 95 per cent of the total number of cases the ulcer lies within  $1\frac{1}{2}$  inches of the pylorus. Others among them Mayo, Balfour, Haberer, and Strauss, also have noted in their operations that most of the ulcers occur in the pyloric region of the stomach and in the first part of the duodenum.

# EXPERIMENTAL STUDIES

During the past 5 or 10 years many medical schools and hospitals have carried on experimental studies to produce ulcers and to find the cause of this disease. Rosenow showed that ulcer of the stomach is often associated with a streptococcus infection in the ulcerated area that foci of infection, such as in tonsils and teeth, harbor the streptococcus and predispose to ulcer, and that the streptococcus isolated from the ulcer and from the distant focus has elective affinity for the stomach, producing hæmorrhage and ulcer on intravenous injection. He injected many dogs and rabbits and 91 per cent of them developed lesions of the stomach, mostly in the lesser curvature. Of 168 animals injected with 37 strains of streptococci from patients with gastric ulcer 68 per cent had lesions of the stomach, particularly on the lower curvature.

Nakamura injected 28 rabbits with living streptococcus isolated from the tonsils of a male patient with ulcer, and 23 of these rabbits developed lesions of the stomach, mostly in the

pyloric region. The streptococcus which had been injected was later found to be present in those regions where the ulcers had formed.

Haden, in conducting a study of 12 cases of peptic ulcer in the attempt to establish a possible causal relation between dental infection and ulcer, made cultures from foci of infection in dental areas and injected 45 rabbits intravenously. At necropsy 53 per cent of these rabbits showed gross lesions on lesser curvature and first part of the duodenum.

Boldyreff, through experiments, found that the high acidity of the gastric juice as it flows from the glands is lowered to normal ranges automatically by the constant regurgitant influx of duodenal juice into the stomach. This duodenal fluid is composed of pancreatic juice, bile, and succus entericus. Neutralization of gastric acidity by this regurgitating fluid is an important part of the digestion. On this basis, Mann and Williamson, also Morton, did the following experiments to show the relation between the acid and the production of ulcers.

*Experiment 1.* This operation was called a surgical duodenal drainage and the operative procedure was as follows: The pylorus was severed and the distal end closed, the first part of the jejunum was severed and the proximal end closed. End to end anastomosis was then made between the proximal end of the severed pylorus and the distal end of the severed jejunum and the continuity of the gastro intestinal tract was thus restored. Then, to form an outlet for the closed segment of gut consisting of the duodenum and a small part of the first portion of the jejunum, a side to side anastomosis was made between this closed portion of jejunum and the lower ileum about 25 centimeters proximal to the ileo cæcal valve. The result of this was to substitute the jejunum functionally and anatomically for the duodenum. Thus the secretion poured into the duodenum was drained far down into the ileum and the gastric contents flowed into the jejunum without being mixed with the duodenal contents. Surgical duodenal drainage, shunting the alkali in the duodenum to the ileum and precluding the possibility of regurgitation of alkali as far as the region of the pylorus caused an acid alkali imbalance in the stomach and the intestine into which it emptied by the practically complete removal of alkali from the region. The result of this experiment was that in 100 per cent of the cases peptic ulcers developed in the jejunum which took the place of the duodenum, just distal to the suture line. When the gastric contents were expelled from the stomach into the jejunum without being mixed with the duodenal contents the ulcers developed at the site where the

# ANATOMICAL CONSIDERATION OF THE ULCER BEARING AREA (LESSER CURVATURE OF THE STOMACH, PYLORUS, AND FIRST PART OF THE DUODENUM)

MONSIEUR HORN AND NEW YORK

**I**N comparing statistics on ulcers in the old and new textbooks we find a marked difference, for the percentage of cases is far greater in the recently published volumes. This, however, does not mean that ulcer has become more prevalent but it does show the great strides that have been made in the study of the disease.

Formerly, the general practitioner diagnosed it incorrectly as indigestion, for there were comparatively few methods of study. In recent years, with the aid of the X ray which has made possible the study of both the normal and the pathological stomach, with the development of surgery to make the stomach and intestines available for direct study of the pathology of the ulcer, and with the findings from physiological experiments on the normal and pathological stomach there have been radical changes in the conception of the production and development of ulcer. We have discovered ulcer to be a common occurrence and consequently statistics now show a great increase in the percentage of its frequency.

The question then arises as to whether ulcers occur in selected regions of the stomach and duodenum. We can determine this by investigating the findings from four different sources viz (1) the necropsy findings, (2) the statistics of surgery, (3) the experimental studies, and (4) the X ray findings.

## NECROPSY FINDINGS

In numerous large hospitals throughout the world, particularly in government and city hospitals, it is the custom to make necropsies on the patients who succumb there. Following are some of the statistics that have been compiled from the necropsies in these institutions.

Brinton found that of 205 ulcers 42 per cent were on posterior surface and 26.8 per cent on lesser curvature. Fenwick's statistics

show that in an analysis of 1015 cases of gastric ulcers nearly 76 per cent were situated in the pyloric region of the stomach near the lesser curvature and on its posterior surface. Collins, in a study of 262 cases, found the ulcer in the first portion of the duodenum in 242 cases. In Perry and Shaw's series of 149 cases there were 123 in which the ulcer was in the first part of the duodenum. Welch's figures show that 78 per cent of all chronic ulcers occupy the lesser curvature, the posterior wall, and the region about the pylorus. Martin's combined statistics of 2000 cases and the figures given by most later pathologists differ from Brinton's in placing the largest group (35 per cent) on the lesser curvature and giving the posterior wall (with 28 per cent) the position of next greatest frequency. Ruth Meyer found 31 per cent on the small curvature, 21 per cent on the posterior wall and 13 per cent in the pyloric region. Bennett states that fully three fourths of all chronic peptic ulcers occur in proximity to the pyloric canal but that, if more recent ulcers be considered in a group, the larger number occurs in the stomach especially in the region of the lesser curvature. Bolton notes that ulcers of the duodenum occur with remarkable constancy in the anterior wall of the organ and in 93 per cent of these cases in the first part of the duodenum. The ulcers are usually found on the anterior or posterior surface of the duodenal cap. Clairmont has observed 73 per cent on the posterior wall and 60 per cent on the anterior. Bassler says that after considering the relative numbers of cases in the four portions of the duodenum it can be definitely stated that the nearer the pylorus the greater is the percentage of ulcers. Practically all of those in the first portion extend to within  $\frac{3}{4}$  inch of the pyloric sphincter and the deepest portion of the ulcer is just outside the pylorus, where the acid chyme readily affects the intestinal mucosa.

merous toward the cardiac sac, on which they thin out and disappear. The circular fibers of the pyloric sphincter are not continuous with those of the duodenum. The latter are separated from the former by a hiatus of connective tissue, which may in the adult be 3 millimeters thick. The circular fibers of the pyloric canal are much more numerous than those of the pyloric vestibule along the greater curvature. Hence the increase in thickness is well marked at the sulcus intermedius.

*The internal layer fibers.* The internal layer of oblique muscle fibers forms a *tænia* on either side of the lesser curvature. The two *tæniæ* blend with each other round the left side of the cardiac orifice, to present a horseshoe shaped appearance, the arms of the horseshoe lying parallel to and above the lesser curvature as far as the *incisura angularis*. The *tæniæ*, if followed toward the pyloric part, are found to give off fibers which bend toward the greater curvature at an acute angle and mingle with the fibers of the circular coat. At the level of the *incisura angularis* the *tæniæ* have disappeared, the whole of their fibers having merged with the circular fibers. The internal layer is entirely limited to the cardiac part of the stomach.

The combination of these different layers results in the formation of a muscular sac which has its distal or pyloric portion formed of a strong and powerful wall of well developed muscular fibers. In the rest of the sac the wall is thinner and the muscular development much less pronounced.

#### SUBMUCOSA

The submucosa in the stomach consists of a lax connective tissue which unites the muscular coat with the mucosa. The submucosa is readily stripped off the muscular coat but is quite adherent to the mucosa, with which its tissue is continuous. The vessels and nerves run in the bed formed by the submucosa before they break up to enter the mucosa. The laxity of the mucosa enables it to become rugous when the muscular coat contracts. In the pyloric region the muscular fibers are bulkier and more separated from each other than in the cardiac portion of the stomach. Hence the tissue of the submucosa penetrates

farther between the fibers of the muscularis in the pars pylorica than in the rest of the organ. The submucous connective tissue even forms a barrier between the circular fibers of the pyloric and duodenal muscular coats. The evidence seems to indicate that, along the gastric pathway, in the vestibule, and in the pyloric canal, the submucosa is firmer in texture and the muscularis mucosæ better developed than in the other parts of the stomach.

#### MUCOSA

The mucous membrane of the stomach consists of an epithelium of cylindrical cells, a basement membrane, a corium into which the glands extend, and double muscular mucosæ. The inner layer is circular and the outer is a longitudinal one which separates the mucous membrane from the submucous coat. The tissues of the mucosa and submucosa are, however, continuous. The mucosa is thinnest in the region of the fundus, where it is only 5 millimeters thick. It becomes progressively thicker from cardia to pylorus, measuring 0.5 to 1.5 millimeters in depth at former situation and 2.2 millimeters at latter. The pyloric mucosa is closely attached and relatively smooth.

Along the lesser curvature are found four well marked longitudinal mucosal folds, which extend through the zone of the isthmus, spreading out in fan like shape into the pyloric canal and forming the gastric pathway, which is sparsely supplied with widely separated folds. The convolutions of the greater curvature are, on the contrary, very numerous, freely movable, and without definite arrangement. The line of demarcation between the mucous membrane of the gastric pathway and that of the corpus is indicated by the course of the oblique fibers, which, according to Bauer, act as a kind of sphincter between the corpus on the one side and the gastric "street" and pyloric canal on the other. A further point of difference is that, during contraction of the stomach, the longitudinal mucosal folds of the street are stretched and under tension, especially in the region of the isthmus, while the mucosa of the corpus becomes redundant and convoluted (Fig. 1).

Rugæ are found in the mucous membrane of the contracted stomach. The rugæ are, as



gastric contents can impinge directly and probably with great force upon the intestinal mucosa.

*Experiment 2.* Areas of gastric mucosa were excised following the operation for surgical duodenal drainage. Healing of the denuded areas was always delayed but the delay was most marked in areas on the lesser curvature and in more than 50 per cent of the cases chronic peptic ulcers developed there.

*Experiment 3.* (a) Twenty one experiments were done in which patches of jejunum were transplanted into the wall of the stomach at various points and observed for long periods and it was found that ulcers developed in the lesser curvature of the stomach. (b) In 13 of these same experiments surgical duodenal drainage was instituted after the patches had been normal from 80 to 479 days. Ulcers developed in the lesser curvature near the pylorus.

*Experiment 4.* Another experiment was done in which the common bile ducts and pancreatic ducts were transplanted into the terminal ileum. Thus the alkali that should have flowed into the first part of the duodenum went into the lower part of the intestines and the first part of the duodenum had no alkali to neutralize the acid that flowed in from the stomach. The result was that later ulcers developed in the duodenum just beyond the pylorus.

*Results.* These experiments show that there is a definite tendency toward the formation of peptic ulcer on the lesser curvature of the stomach. Areas on the greater curvature healed completely while areas on the lesser curvature healed very sluggishly and went on to chronic peptic ulceration in as high as 62.5 per cent of prolonged experiments. Peptic ulcer of the jejunum formed following surgical duodenal drainage in almost 100 per cent of the cases and when areas of gastric mucosa were excised following the operation for surgical duodenal drainage healing of the denuded areas was always delayed and chronic ulcers formed.

#### X RAY FINDINGS

For the past 15 years there has been a marked advancement in the X ray diagnosis of gastro intestinal diseases, particularly of ulcers of the stomach and duodenum. The roentgenologists, Schlessinger, Assman, Knox, Groedel, and Carman, in their writings based on certain accepted direct and indirect signs by which the diagnosis of ulcers are made, state that most ulcers occur in the lesser curvature of the stomach and the first part of the duodenum.

As shown above, it can now be definitely stated that ulcers of the stomach in the greater percentage of cases are located on the lesser curvature of the stomach in the pylorus and the first part of the duodenum (Fig. 1). The question naturally arises as to whether there

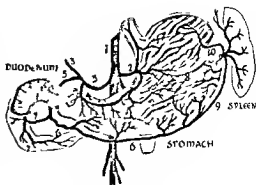


FIG. 1. Diagram of the stomach and duodenum showing: 1. The mucosal folds in the fundus and greater curvature convoluted and redundant while in the pylorus they are stretched and parallel. 2. Relation of arterial blood supply to the stomach: 1. cardiac trunk, 2. left gastric (coronary), 3. hepatic, 4. right gastric, 5. gastroduodenal, 6. right gastro-epiploic, 7. superior pancreaticoduodenal, 8. splenic (dotted line behind stomach), 9. left gastro-epiploic, 10. vasa brevia. C. Distribution and frequency of ulcers in the stomach and duodenum represented by black dots.

is any histological and anatomical explanation therefor. It is expedient first to review the more important anatomical features of the stomach including its blood supply, and also the more important functional phenomena.

#### MUSCULAR STRUCTURE OF THE STOMACH

Generally speaking there are three layers in the muscular coat of the stomach—an outer longitudinal, a middle circular, and an inner set of fibers.

*The longitudinal fibers.* The longitudinal fibers are continuous with those of the esophagus and are massed along the lesser and greater curvatures. Those which pass over the greater curvature become thin and spread over the fundus. In the region of the gastric tube and the pyloric part the longitudinal fibers of the greater curvature are well developed. In the region of the pyloric canal the longitudinal fibers form a complete coat rather thicker along the greater than along the lesser curvature. The greater part of the longitudinal fibers passes into the circular coat of the pyloric canal to terminate among its fibers, some reaching the submucosa.

*The circular fibers.* The circular fibers are most thickly massed in the pyloric part and in the gastric tube. They become much less nu-

merous toward the cardiac sac, on which they thin out and disappear. The circular fibers of the pyloric sphincter are not continuous with those of the duodenum. The latter are separated from the former by a hiatus of connective tissue, which may in the adult be 3 millimeters thick. The circular fibers of the pyloric canal are much more numerous than those of the pyloric vestibule along the greater curvature. Hence the increase in thickness is well marked at the sulcus intermedius.

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gastro-jejunal anastomosis. The pylorus is a typical structure with great freedom of movement.

**Experiment 1.** After exposure of the stomach, the pylorus was exposed by the removal of the greater curvature. The pylorus was always found to be in a position of greatest relaxation. The pylorus was always found to be in a position of greatest relaxation.

**Experiment 2.** A twenty-four-hour fast was followed by a high-calorie diet. The stomach was found to be in a position of greatest relaxation. The pylorus was always found to be in a position of greatest relaxation.

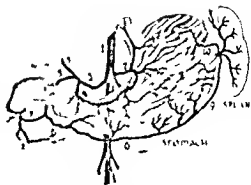
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**Results.** The experiments indicate that there is a definite tendency toward the formation of peptic ulcers on the lesser curvature of the stomach. Areas on the greater curvature healed completely without scars on the lesser curvature healed with scars. An animal went on to chronic peptic ulceration as high as 65 per cent of jejunal ulceration. The ulcer of the jejunum formed a long fistula. Duodenal drainage in all most cases of the stomach and when areas of gastric mucosa were exposed with the operation for surgical duodenal drainage healing of the denuded areas was always delayed and chronic ulcers formed.

#### NEW FINDINGS

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#### SUBMUCOSA

The submucosa in the stomach consists of a lax connective tissue which unites the muscular coat with the mucosa. The submucosa is readily stripped off the muscular coat but is quite adherent to the mucosa, with which its tissue is continuous. The vessels and nerves run in the bed formed by the submucosa before they break up to enter the mucosa. The laxity of the mucosa enables it to become rugous when the muscular coat contracts. In the pyloric region the muscular fibers are bulkier and more separated from each other than in the cardiac portion of the stomach. Hence the tissue of the submucosa penetrates

farther between the fibers of the muscularis in the pars pylorica than in the rest of the organ. The submucous connective tissue even forms a barrier between the circular fibers of the pyloric and duodenal muscular coats. The evidence seems to indicate that, along the gastric pathway, in the vestibule, and in the pyloric canal, the submucosa is firmer in texture and the muscularis mucosæ better developed than in the other parts of the stomach.

#### MUCOSA

The mucous membrane of the stomach consists of an epithelium of cylindrical cells, a basement membrane, a corium into which the glands extend, and double muscular mucosæ. The inner layer is circular and the outer is a longitudinal one which separates the mucous membrane from the submucous coat. The tissues of the mucosa and submucosa are, however, continuous. The mucosa is thinnest in the region of the fundus, where it is only 5 millimeters thick. It becomes progressively thicker from cardia to pylorus, measuring 0.5 to 1.5 millimeters in depth at former situation and 2.2 millimeters at latter. The pyloric mucosa is closely attached and relatively smooth.

Along the lesser curvature are found four well marked longitudinal mucosal folds, which extend through the zone of the isthmus, spreading out in fan like shape into the pyloric canal and forming the gastric pathway, which is sparsely supplied with widely separated folds. The convolutions of the greater curvature are, on the contrary, very numerous, freely movable, and without definite arrangement. The line of demarcation between the mucous membrane of the gastric pathway and that of the corpus is indicated by the course of the oblique fibers, which, according to Bauer, act as a kind of sphincter between the corpus on the one side and the gastric "street" and pyloric canal on the other. A further point of difference is that, during contraction of the stomach, the longitudinal mucosal folds of the street are stretched and under tension especially in the region of the isthmus, while the mucosa of the corpus becomes redundant and convoluted (Fig. 1).

Rugæ are found in the mucous membrane of the contracted stomach. The rugæ are, as

a rule, stellate in the cardiac portion and parallel with the long axis in the pyloric part

The upper portion of the stomach is richly supplied with mucosal folds, which in case of erosion overfold and overlie the affected part with the result that rapid repair ensues. But should any lesion or erosion occur in a portion sparsely supplied, as is the gastric pathway, there is no protection and there is active transit of food and infectious material over that area. Under such circumstances healing becomes especially difficult and ultimately an ulcer will develop.

### GLANDS

The mucous membrane of the stomach contains two distinct varieties of glands. These varieties differ chiefly in that one exhibits only a single type of cell in the lining of the basement membrane, while in the other two distinct types of cells are present. On account of their distribution in the stomach these are generally known as pyloric and fundal glands.

Pyloric glands are deeper and larger and are lined entirely by cells of the chief or central type which secrete pepsinogen or the proferment of rennin. Each of these cells consists of two or three short wavy tubules opening into a common duct. The tubes are lined with finely granular cubical cells, while the ducts have more or less columnar cells. Acid forming or oxyntic cells are absent.

Fundic glands are by far the most numerous. They occur throughout the whole body of the stomach with the exception of the cardiac and pyloric regions. They consist of tubes lined with two types of secreting cells. Projecting from the basement membrane toward the lumen of the duct there is a continuous lining of granular polyhedral cells known as central cells. Between these cells and the basement membrane are large oval cells, opaque and granular in appearance known as parietal or oxyntic cells. It is generally believed that these secrete the hydrochloric acid of the gastric juice, presumably the central cells of all the glands secrete pepsin and other digestive ferments.

According to Bensen and Harvey, the acid forming parietal cells do not produce actual hydrochloric acid but secrete an alkaline fore-

runner of it which is changed by reaction outside the cells.

Beginning at the cardio-oesophageal junction there is a special form of gland, known as the cardiac type, and it has no pepsin secreting function. In that zone the oxyntic or acid cells are few in number and of medium size but about 2 centimeters from the oesophageal orifice on the lesser curvature the cells increase in number and are located mainly in the fundal portion of the glands. The cells become fairly numerous toward the cardio-pyloric junction, they also increase somewhat in size and become more numerous in the necks of the glands. At the cardiopyloric junction there is a fairly sharp reduction in the number of oxyntic cells and only a few scattered acid forming cells are seen beyond the junction. The position of the junction is 60-67 per cent of the distance from the cardiac orifice.

Beginning at the cardio-oesophageal junction the dorsal or greater curvature shows the cardiac glands numerous and the oxyntic cells few in number. Farther on, the acid forming cells are at first few and scattered. They are located mainly in the necks of the glands. From this region to the junction there are alternating decreases and increases in the number of acid forming cells and a sudden cessation at the junction. The junction is 83-87 per cent of the distance from the cardiac orifice.

### ARTERIAL SUPPLY

#### Celiac trunk

I Left gastric (coronary)

II Hepatic

Right gastric

Gastrooduodenal

Right gastro-epiploic

Superior pancreaticoduodenal

III Splenic

Vasa brevia

Left gastro-epiploic

The arterial supply of the stomach comes from the celiac trunk. This short wide vessel lies behind the omental bursa and runs forward for 12 millimeters between the condote lobe of the liver above and the upper border of the pancreas and the splenic vein below. It terminates by dividing into (1) the left gastric artery, (2) the hepatic artery, and (3) the splenic artery (Fig. 1).

The left gastric artery (coronary) runs upward and to the left behind the omental bursa and, passing forward in the left gastric pancreatic fold, reaches the lesser curvature adjacent to the cardia. The artery then runs along the lesser curvature, close to the stomach wall, and anastomoses with the right gastric (pyloric) branch of the hepatic artery. It gives off branches to the lower gullet and to both surfaces of the stomach. Many of these pierce the circular musculature of the gastric pathway and form a plexus in the submucosa.

The hepatic artery runs along the upper border of the head of the pancreas between the layers of the right gastropancreatic fold of the peritoneum to reach the first part of the duodenum. From there the artery passes upward between the layers of the hepatoduodenal ligament to reach the liver. The arterial branches to the stomach are the right gastric and the gastroduodenal vessels.

The right gastric artery arises from the hepatic trunk in the gastrohepatic ligament above the pylorus to which it passes first, then, turning to the left, supplies both sides of the pyloric part of the stomach and anastomoses with the left gastric artery in the region of the incisura angularis. Like the left gastric vessel it is closely applied to the stomach wall.

The gastroduodenal artery descends behind the first part of the duodenum, on the under aspect of which it divides into the right gastroepiploic and the superior pancreaticoduodenal vessels.

The right gastroepiploic artery passes to the left behind the first part of the duodenum and above the head of the pancreas to reach the gastroduodenal ligament (part of the great omentum) between the layers of which it runs parallel to, but some distance from, the greater curvature, to supply the pyloric canal and vestibule with branches. It anastomoses with the left gastroepiploic vessel near the junction of the gastric tube with the pyloric vestibule.

The splenic artery, which is large and tortuous, passes to the left behind the omental bursa along the upper spleen running between the layers of the lienorenal ligaments, and its branches to the stomach pass onward

between the layers of the gastrosplenic ligament. These are the vasa brevia, which supply the fundus proper and adjacent parts of the cardiac sac and the left gastroepiploic, which gives off branches to the gastric tube and adjacent parts of the cardiac sac.

There are two arterial circles, which form along the lesser and greater curvature of the stomach. The smaller circle, along the lesser curvature, is formed by the right gastric, a branch of the hepatic artery, and the left gastric, a branch of the coeliac trunk, which anastomose in the region of the incisura angularis. The larger circle, along the greater curvature, is formed by the right gastroepiploic, a branch of the gastroduodenal artery, and the left gastroepiploic, a branch of the splenic artery, which anastomose near the junction of the gastric tube, with the pyloric vestibule. The branches of the arteries mentioned leave the greater curvature and quickly penetrate the stomach wall in the fundus region, where they ramify.

There are three important points to be noted in considering the arterial blood supply of the stomach.

1 The upper part of the stomach (fundus) receives its blood supply from three different branches—namely, the left gastric, the left gastroepiploic, and the vasa brevia—whereas the lower part (pylorus) is supplied by two branches only—the right gastric and the right gastroepiploic.

2 The fundus receives its blood supply from the main source through two different channels and, in case of a disturbance in one, the deficiency can be supplied by the other. The pylorus, however, receives its blood supply from the same source but through only one channel (the hepatic), and consequently there is no other possible route by which the reserve blood supply may be tapped in case of an emergency.

The fundus, through the left gastric artery, receives a direct blood supply from the main source, which is the coeliac trunk, and therefore the amount of blood supplied to this region is greater. The blood which supplies the other regions of the fundus, through the left gastroepiploic and the vasa brevia, must first pass the splenic before reaching these parts.

and the distance to be transversed from the main source is therefore greater. The pylorus, on the other hand, receives its blood supply through the right gastric and the right gastric epiploic. Before reaching these arteries, the blood must pass the hepatic artery and branches of the gastroduodenal arteries, the distance, therefore, being greater and the blood flow per volume much less in this region.

The arteries of the submucosa, in the pyloric region of the lower lesser curvature of the stomach, are practically terminal vessels and are relatively sparsely distributed, giving a limited blood supply to this area. They are tortuous, anastomose infrequently, and are subject to powerful and repeated forcible constrictions by numerous interlacing, intricate, and frequently contracting muscle bundles. These constrictions tend to interfere with the circulation and, moreover, the terminal vessels are subject to the same tendency to circulatory interference by reason of easy blocking as are the terminal vessels in the brain or kidney and are especially liable to harbor the foci of anemia.

In his recent study of the anatomical arrangement of the arteries of the stomach, Berlet has proved that the arteries in this region are predisposed to circulatory disturbances and are deficient in their ability to establish an adequate collateral circulation.

The arteries of the fundal wall are not terminal, as in the pyloric region, and are less tortuous than the arteries there but, on the contrary, anastomose more freely and on account of the scarcity of interlacing muscle bundles around the arteries, are less subject to constrictions and blocking. The muscular wall of the fundus, which is much thinner than that of the pylorus, serves as a reservoir for the food, rather than taking an important part in the mechanical action of the stomach. Consequently, there is less muscular pressure on the arteries which supply the fundus than on the pyloric arteries and less danger of interference with the circulation of the former than of the latter.

A number of experiments were undertaken to prove that there is a difference in the blood supply to the pyloric and fundic regions and,

on ligation in the regions of the left gastro-epiploic arteries, there was no recognizable influence on the fundic mucosæ, because they anastomosed with other sources, whereas ligations in the right gastric or right gastro-epiploic or in both vessels led to localized nutritional disturbances.

#### DUODENUM

As previously mentioned, most ulcers are located in the first portion of the duodenum (Fig. 1), the place of predilection for ulcers in the duodenum being, as in the case of the stomach, close to or upon the lesser curvature.

The explanation of such a phenomenon can probably be found in the anatomical and histological features of the duodenum. The first portion of the duodenum (bulbus duodeni), from a structural point of view, stands out as an unique organ, and, histologically, stands between the stomach and the small intestine and possesses some of the characteristics of both.

The muscular structure of the duodenum is somewhat similar to that of the stomach. The muscular coat of the duodenum consists of two layers: the external layer, made up of longitudinal muscles and the internal layer of circular muscles. The longitudinal muscular coat completely envelops the duodenum and shows marked irregularities in thickness in its different portions. Its greatest development and thickness is along the border of the lesser curvature of the stomach, in contrast to other regions of the duodenum, where the muscle bundles are so thin that the circular fibers can be seen through them. The longitudinal muscle fibers form a band, along the lesser curvature border of the duodenum, which varies in width from 1 to 2 1/4 centimeters. These fibers penetrate the pyloric sphincter and intertwine with terminal fibers of the longitudinal muscles of the stomach at the sphincteric ring except on the greater curvature side of the duodenum. Some also enter into the duodenohepatic ligament which is attached at the upper border of the duodenum and forms the only suspension mechanism of the duodenal bulb.

The circular muscle fibers originate in the lesser curvature border of the duodenum and

run in somewhat arc like fashion to the longitudinal fibers. These circular fibers start on a plane internal to that of the pyloric sphincter. According to Ochsner, the circular muscular coat has sphincteric bands of varying widths and at varying sites in the organ. Their most common position is 3 to 10 centimeters distal to the common bile duct.

The mucosa of the duodenum is thrown into large transverse raised folds, the valvulae conniventes of the intestinal tract. These are not present in the first portion of the duodenum, where the mucosa is smooth, but begin about the junction of the first and second portions as small folds, increasing in size until approximately the full size and height of these folds is seen in the upper part of the small intestine (jejunum). The submucosa is similar to the submucosa of the stomach and needs no comment.

There are certain glands peculiar to the duodenum, known as Brunner's glands. They are most numerous in the first part of the organ and in the second part as far as the common bile duct. Beyond this point they decrease in number and finally cease at or about the duodenojejunal junction. Their final distal limit forms, therefore, a very useful indication of the termination of the duodenum.

The arterial supply of the duodenum comes partly from the coeliac axis vessel via the superior pancreaticoduodenal branch of the gastroduodenal artery, which itself arises from the hepatic trunk, and partly from the superior mesenteric artery through the inferior pancreaticoduodenal branch. These two vessels form a loop around the head of the pancreas. Wilkie believes that the first part of the duodenum does not get its blood supply direct from the main trunk of the superior pancreaticoduodenal vessel but through a branch which arises from the proximal part of the gastroduodenal artery. This branch was called by Wilkie the supraduodenal vessel and it presents no anastomosis with neighboring arteries. The little communication it might have with the pyloric or duodenal branch of the right gastroepiploic artery is never very free. Mayo has drawn attention to the anemic spot which often appears on the ventral wall of the first part of the duo-

denum if the gut be stretched by traction on the pylorus. It is therefore clearly seen that, as Wilkie believes, the blood supply to the first portion of the duodenum is easily disturbed.

#### MECHANICAL ACTIVITY OF THE STOMACH

The human stomach is divided into two parts, namely, the pylorus and the fundus. The muscular pyloric part is burdened with the food, mixes it thoroughly with the acid gastric juice, and breaks it down by muscular action. It bears the brunt of the trauma administered to the gastric mucosa when the stomach is emptied by mechanical contraction. The stomach impels digested material most directly along the lesser curvature to expel it through the pylorus, therefore the lines of force exerted by the contracting musculature always tend to converge along the lesser curvature. The muscles in this part of the stomach are always active and as a result they are bulkier and heavier than in the fundus. Peristalsis, which usually starts in the middle of the stomach, is most active in this region and the blood vessels in the pylorus are constantly subject to a circulatory disturbance due to the muscular contractions.

The fundus, on the other hand, is less muscular than the pylorus, has very little mechanical activity, and acts merely as a reservoir to contain the food. The acid secretion is supplied by the oxyntic glands which are most numerous in this region.

The food, after it is digested, is expelled by the muscular activity of the pylorus through the duodenum into the jejunum. It impinges with full force upon the mucosa of the first part of the duodenum causing great tension there, which gradually passes into the other parts of the duodenum. With each expulsion of food from the pylorus, a certain amount of acid passes through the sphincter into the duodenum, thus affecting the mucosa of the first part, which is constantly imbedded in the alkaline secretion.

#### SUMMARY

There are undoubtedly sufficient anatomical reasons to explain the existence of ulcers in the area which comprises the lesser curvature of the stomach, the pylorus, and the first



part of the duodenum. I shall give a summary of the peculiarities of this area, as it compares with other parts of the stomach and duodenum.

1 The pyloric wall is firm, strong, and well developed, and is composed of thick longitudinal and circular muscles while in the fundus the walls are thinner. The internal layer of oblique fibers is limited entirely to the cardiac part of the stomach.

2 The submucosa is firmer in texture, bulkier, and better developed in the pyloric region than in other parts of the stomach. It is adherent to the mucosa in this region but is more lax in the fundus, where it enables the mucosa to become more convoluted when the muscular coat contracts.

3 The mucosa in the pyloric region is closely attached, smooth and thick while in the fundus it is thin. The pylorus is sparsely supplied with folds and the convolutions are numerous, freely movable and without definite arrangement. The longitudinal mucosal folds in the lesser curvature are stretched and under tension, while in the fundus they become redundant and convoluted.

4 Rugæ are found in the mucous membrane of the contracted stomach. The rugæ are, as a rule, stellate in the cardiac portion and parallel to the long axis in the pyloric part.

5 The pylorus is provided with the pyloric glands only while the fundus possesses gastric cells which secrete acid. The central cells which form the pepsin and other digestive ferments, also are in the fundus. The acid forming cells extend for approximately 60-70 per cent of the distance from the cardia to the pylorus, along the lesser curvature, and 83 per cent of the distance between the orifices along the greater curvature.

6 (a) The fundus receives its blood supply from the main source through three different branches, while the pylorus is supplied from the same source through two branches only. (b) The fundus is supplied with blood direct from the main source and one primary branch, hence the amount of blood per volume is greater there than in the pylorus, which is supplied only by primary and secondary branches, the distance which they traverse

being longer, and the amount of blood per volume much less. (c) The arteries in the pylorus are practically terminal vessels sparsely distributed and tortuous. They anastomose infrequently and are subject to powerful constrictions by numerous interlacing frequently contracting muscle bundles. The arteries in the fundus are not terminal, are less tortuous, anastomose more freely, and, on account of the scarcity of interlacing muscle bundles are less subject to constrictions.

7 The muscles of the pylorus are bulky and heavy for it bears the burden of the food mixes it with the acid gastric juice, and breaks it down by muscular action. The fundus serves merely as a reservoir to contain the food and does not take an important part in the mechanical activity of the stomach, hence its muscles are much thinner than those of the pylorus.

8 The muscles are thicker and bulkier in the first part of the duodenum than in any other part, and the sphincteric rings and mucosal folds which are lacking elsewhere, are located in this region. Glands known as Brunner's glands are most numerous in this part of the duodenum.

9 The first part of the duodenum is under a greater tension than the remainder of it because of the force exerted by the food which is expelled from the pylorus. The mucosa in this region which is constantly unbedded in the alkaline secretion is frequently damaged by the mixed acid food which is expelled from the stomach.

#### BIBLIOGRAPHY

1. BASSLER: Diseases of the Stomach and Upper Alimentary Tract. Davis Co. 1913.
2. BENNETT: Stomach and Upper Alimentary Canal. New York: William Wood and Company, 1913.
3. BENSLER, R. and HARVEY, B. C. H. Tr. Chicago Path. Soc. 1913, ix, 14.
4. BOLDVREEF: Quart. J. Exper. Physiol. 1914, viii, 1.
5. BOLTON, C.: Ulcer of the Stomach. Arnold, 1913.
6. BRENTON: Ulcer of the Stomach. 183, pp. 11, 12, 48.
7. CLAIRMONT, P.: Die pathologische anatomischen Veränderungen des Duodenums bei Ulcus. Zurich, 1913.
8. COLLINS, H.: Etude sur l'ulcère simple du duodenum. Thèse de doct. Paris, 1894.
9. FENWICK: Ulcer of the Stomach and Duodenum. 1900, p. 3.
10. HADEN, R. L. and BOLTON, P. T.: Focal infection in peptic ulcer. J. Am. M. Ass. 1921, lxxxiv, 429. The elective localization of bacteria in peptic ulcer. Arch. Int. Med. 1923, xxxv, 437.

11. MANN and WILLIAMSON The experimental production of peptic ulcer *Ann Surg* 1923 lxxvii 409 422
  12. MARTIN C F Osler and McCrae's System of Medicine 1900 v 183
  13. MAYO W J Anemic spot on the duodenum *Surg Gynec & Obst* 1908 vi 600
  14. MORTON C B Observations on peptic ulcer findings in experimentally produced peptic ulcer *Ann Surg* 1928 March
  15. MOYNIHAN Duodenal Ulcer Philadelphia Saunders Company 1910
  16. NAKAMURA T A study on focal infection and elective localization in ulcer of the stomach and in arthritis *Ann Surg* 1924 lxxix 29
  17. OCHSNER A J Further observations on the anatomy of the duodenum *Am J M Sc* 1906 cxxxi 1
  18. PERRY and SIRAW Quoted by Moynihan in Duodenal Ulcer Philadelphia Saunders 1910
  19. ROSENOW E C The causation of gastric and duodenal ulcer by streptococci *J Infect Dis* 1916 xix 333 Etiology of spontaneous ulcer of stomach in domestic animals *Ibid* 1923 xxxii 334
  20. RUTHEVEYER Osler and McCrae System of Medicine v 195
  21. WELCH Pepper's System of Medicine 1885 ii 503 504
  22. WILKIE D P D The blood supply of the duodenum *Surg Gynec & Obst* 1911 xiii 399
- ADDITIONAL BIBLIOGRAPHY
23. ALFESCHNATER O V Die Muskulatur des menschlichen Magens *Wien Sitzungsbd k Akad d Wissensch* 1894 ciii 75 95
  24. ASCHOFF L Lectures on Pathology New York Paul B Hoeber 1924
  25. Idem Ueber den Engpass des Magens *Jena Gustav Fischer* 1914
  26. CRYMILE P T The muscle of Treitz and the plica duodenojejunalis *Brit M J* London 1910 ii 1 156
  27. FORBES GOSTA Ueber die Beziehung der Roentgenbilder des menschlichen Magens zu seinem anatomischen Bau *Fortschr a d Geb d Roentgenstrahlen* Sup vol xxx
  28. HORTON BARNARD TAYLOR Pyloric musculature with special reference to pyloric block *Am J Anat* 1928 xli No 2
  29. JONVESCO TH Tube digestif Poirier et Charpy's *Traite d'anatomie humaine* Paris 1912 iv No 1
  30. JACKSON C M 1923 Morris Human Anatomy Philadelphia P Blakiston's Son and Company 7th ed p 1186 iv No 1
  31. KAUFMAN R Ueber Kontraktionsphenomene am Magen *Wien klin Wchnschr* 1907 xv 063
  32. KEITH A and JONES F W A note on the development of the fundus of the human stomach *J Anat & Physiol* 1902 xxxvi 34 35
  33. PETERSON A M The form of the human stomach *J Anat & Physiol* London 1913 xlvii 256
  34. PAVLOFF J P The work of the digestive glands Translated by Thomp on W 2d ed London 1910
  35. RADASCH H F The distribution of acid cells along the dorsal curvature of the stomach and the possible relation to the occurrence of gastric ulcer *Surg Gynec & Obst* 1923 xxxvi 87 89
  36. ROBERTSON H E and HARGIS L H Duodenal ulcer an anatomical study *Med Clin North America* 1925 viii 1063 1092
  37. SCHWABE C Beitrage zur Kenntnis des menschlichen Magens *Ztschr f Morph u Anthropol* Stuttgart 1912 Sonderh 2 p 1
  38. STRECKER F Der Vermagen des Menschen *Arch f Anat u Entwicklungsgesch* Leipzig 1908 p 119
  39. TODD T W The Clinical Anatomy of the Gastro Intestinal Tract Manchester 1915
  40. WALDEYER W Die Magenstrasse *Sitzungsbd k preuss Akad d Wiss Berlin* 1908 xxix 595
  41. WILMS Umschnurung und Verschluss des Pylorus durch Fasziestreifen *Deutsche med Wchnschr* Berlin 1912 xxxviii 101
  42. WERNSTEDT W 1907 Grundform und Kontraktionsformen des menschlichen Magens einige Gesichtspunkte ueber das Studium der Form des Magens und der Benennung seiner Teile *Arch f Anat* p 120-1 3

# PERI-ARTERIAL SYMPATHETOMY IN CIRCULATORY DISORDERS OF THE EXTREMITIES

## REPORT OF CASES

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**I**N 1924, when I presented my first paper<sup>1</sup> on peri arterial sympathectomy before the Clinical Congress of the American College of Surgeons, it seemed that a new era had dawned with regard to the relief of those circulatory disorders of the extremities that tend to eventuate in gangrene. Lerich, sponsor of the procedure, had given glowing reports of his successes and other foreign surgeons had had their triumphs, so that it did not surprise me when certain of my operative trials gave the much sought relief. The report referred to comprised 9 cases and contained a detailed description of the operation together with appropriate drawings.

I mention this latter because certain of the surgeons who undertook to do the operation had little or no satisfaction with it and as a result the procedure in this country has found scant favor. It may be that too much has been expected, but one cannot help but wonder whether the details of the operation have been followed out faithfully and efficiently. Blood vessel surgery, to be successful requires a modicum at least of special training and the removal of the adventitial coat of a major artery that is pulsating cannot be regarded as but another operation in the long list of a busy general surgeon's morning work.

Then, too, the question naturally arises as to the character of case in which the operation has been done. For unless one has some special knowledge of vascular conditions that affect locomotion he is more prone to suggest sympathectomy in a given case than is the surgeon who has such knowledge. Patients quite naturally do not relish the idea of losing their limbs and, as has often been remarked, amputation is but a confession of failure. Even so it is better surgery to remove a member when truly indicated than to attempt a reconstructive operation which, by every rule we

have to guide us, is doomed to failure. Furthermore, it throws no slight on a procedure that under favorable circumstances still seems to have much to commend it.

My own series of cases in which sympathectomy has been done has now grown from 9 to 28. It could have been much larger, but from the beginning I laid down certain indications for the operation and in so far as was possible adhered to them religiously. Dead tissue cannot be restored to life and morphine addicts practically never get relief from this operation or any other save amputation. Indeed, the most serious contra-indication of all is the morphine habit and unless I can get my patients cured of it I absolutely refuse to do a sympathectomy on them. Certain of my early non successes were directly attributable to a failure to recognize clearly the importance of opium as a contra-indication.

In one regard, however, I have changed my mind completely. I formerly laid much stress on the state of the arterial circulation. It is of importance, naturally, and generally speaking, the better the arterial supply the better the chances of success. Certainly, the patient who still has pulsation in the popliteal artery would seem to be better off than the one who has not. So, too, the presence of pulsation in the femoral artery is more heartening than is absence of it. But I no longer regard as hopeless those patients whose entire arterial system—femoral, popliteal, and on down—is absolutely blocked. Interesting too, is the way this change of opinion came about. Upon several occasions I did an exploration just to be absolutely sure that the femoral artery was blocked and in each instance when the pre-operative diagnosis proved to be correct nothing further was done—except in 1 case. In that case for some inexplicable reason I did the regular sympathectomy anyhow—and was rewarded with tempo-

<sup>1</sup> Bernheim, Bertram M. Peri arterial sympathectomy: its use in circulatory diseases of the extremities. *Bull. & Gynec. & Obst.* June 1925, 21, 828-835.

\*R. ally 31 but 3 of them at 100 ex. 1 to be 21 died in this report.

rary, if not permanent, relief of pain and improvement in the general condition of the leg. So much improvement was gained that I have since carried out the operation in every detail upon several similar patients and one of them is all but the most brilliant success in the series.

Nor do I hold with those who consider the operation applicable to Raynaud's disease only. Perhaps the most successful case I have had was that of a man 68 years old who had a generalized arteriosclerosis and whose femoral artery was typical of that disease. And in 3 other highly satisfactory cases the patients had and still have the most typical thrombo angitis one could wish to see, including superficial migrating phlebitis. Each case must be considered as an entity and the decision to operate or not to operate had best depend solely on the physical findings, quite regardless of the clinical or pathological diagnosis. It has been my feeling throughout the years that all vascular diseases that affect the vessels of the extremities are so closely related as to be really indistinguishable except in their early stages. However they may begin and however different their incipient signs and symptoms are, they all tend to obstruction of main blood channels by obliterative processes of one form or another, they all have pain, they all tend to ulceration, they all point toward ultimate gangrene, and they reach the end unless a collateral circulation adequate to nourish the tissues is established.

I lay great stress on the blood pressure and have made two contributions on the subject.<sup>1</sup> For some unknown reason a low pressure—oftentimes a very low pressure—is an almost constant finding in those who have serious disturbance of their peripheral vascular system. And the lower the pressure the worse the prognosis. It is a simple matter of mechanics and is not difficult to understand. If one has not a pressure of some force back of his blood stream, it is idle to hope for the development of those circuitous routes of blood flow that go under the generalized term of collateral circulation. Rarely does a real hypertension patient have a gangrene or even a threatened

gangrene. Such patients may have a gangrene after a cardiac break, and I have seen several such, but it is usually after a break. But if compensation can be restored without too great delay, and maintained, gangrene will be averted. If it cannot, gangrene will supervene. In other words, any circulatory derangement of the extremities in the presence of a low blood pressure is most dangerous. This cannot be emphasized too much.

But this blood pressure feature is of particular importance to me because I look upon periarterial sympathectomy more in the light of a "tiding-over affair." It is true that the procedure was conceived with the idea of releasing arteries that have been spasmodically closed—the Raynaud type—and that may or may not be correct, depending on one's anatomical viewpoint. But, in practically all the cases I see, the arteries are closed not by spastic contractions of the blood vessel wall but by an obliterative process of one kind or another, most usually thrombus formation. And nothing can clear them. So that all I hope to do by a sympathectomy is to relieve pain—by breaking the sympathetic nerve chain—to dilate any vessels that can be dilated thus, and to secure a bit better blood flow in this way to the parts that need it. If that can be accomplished—if the patient can be tided over his acute stress—it gives one a chance to develop his collateral blood channels, provided he has a blood pressure sufficiently high to do it, or provided his low pressure can be raised a bit, as is occasionally possible.

A follow up of the 9 cases reported in 1925 reveals the fact that one of the successes turned out later to be a failure in that the patient returned with ulcerations that could not be healed and pain that could not be controlled. Amputation followed. To counterbalance this, though, 2 cases, the one that was considered as being only improved and the one that was regarded as doubtful, have turned out quite successfully in that both patients have had little or no trouble and are able to attend to their usual duties. Analysis of these 9 cases, then, shows 4 failures and 5 (55.5 per cent) successes. There was 1 death among the failures. This occurred 2 days after the

Bernheim, Bertram M. Blood pressure findings in circulatory disorders of the extremities. *J. Am. M. Ass.* 1927, LXXVII, 799-800. The influence of blood pressure in circulatory disorders of the extremities. *South. M. J.* 1927, XX, No. 4.

TABLE I—ANALYSIS OF INTERSIFRIS

Operations	Cases
Induriferitis obliterans	2
Thrombo-angitis obliterans	15
Kaynaud's disease	5
Arteriosclerosis	3
Erythromelalgia (arteriosclerosis)	3
Total operations on 25 patients	28
Deaths	
Hemiplegia 2 days after second sympathectomy	1
Surgical infection	1
Cardiorenal after amputation	1
Total deaths	3
Failures	17
Successes (33 per cent)	11

patient's second sympathectomy and was occasioned by a hemiplegia—an occurrence, by the way that is not so infrequent in thrombo-angitis obliterans. I had one patient who died of it on the eve of his scheduled operation.

Study of the 19 additional cases shows that 13 operations resulted in failure and 2 of these patients died. One died as a result of an accidental surgical infection, while the other died following the amputation that was done when sympathectomy failed to help matters. There were 6 successes or 31.5 per cent—a very respectable percentage,<sup>2</sup> when one con-

The explanation of the greater percentage of successes among the first group of cases is had in the fact that certain cases were done in the

siders that in certain cases the operation was purely experimental and failure was almost a foregone conclusion, while in practically all of them it was late in the course of their disease processes, much valuable time had been lost, and sympathectomy was done as a last resort.

## ANALYSIS

A complete analysis of the entire series is shown in Table I.

In view of the fact that the operation is not especially dangerous, that it can be done under local anesthesia as well as under general anesthesia, that hospitalization of hardly more than a week is required, that there is little or no discomfort following it, that it is usually well borne even by patients over 60 years of age, and that in certain cases the result is actually brilliant, it would seem fair to conclude that in selected cases of circulatory disorders of the extremities periartral sympathectomy really has much to offer.

Second group by way of experiment—always of course with the complete understanding on the part of the patient that it was a trial only. Two of these cases were for erythromelalgia, it was for a most usual case of scleroderma that it was thought to be linked up with Raynaud's disease and another was for a most vicious nerve disorder which might possibly have concerned the sympathetic innervation of the arteries. In one case was there a threatened gangrene and did gangrene supervene after operation. Again was the chief symptom. The operation did not relieve the pain in any case so I count all of them as failures. This explains in a great measure the high percentage of failures between the first and second series.

# THE SEDIMENTATION TEST IN PREGNANCY AND IN THE PUERPERIUM

## A STUDY OF FIVE HUNDRED FORTY PATIENTS

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THE blood sedimentation test as a non-specific reaction in various infections and destructive diseases has been studied by many investigators during the past 10 years. Its clinical significance in acute and chronic infectious disease, and in malignant conditions, has been discussed at considerable length in numerous papers. Its significance in pregnancy has, however, not been studied so intensively, although the fact that the sedimentation rate is increased in the pregnant state was pointed out by Fåhræus, in 1918.

The purpose of the present study is to evaluate the sedimentation of the erythrocytes in pregnancy, with special reference to its relation to anemia. The existence of a blood deficiency in pregnancy was described by us in a previous paper.

A true estimate of the value of the blood sedimentation test is rendered difficult by the lack of standardization in the methods employed in the test. A modification of either of the two best known methods is usually employed in the determination of the sedimentation rate. In one method (Westergren) the distance which the erythrocytes have settled in a given period of time is observed. In the Linzenmeier method, the time required for the sedimenting cells to reach a certain distance in the tube is recorded.

In this study the Cutler graph method (7) was employed because of its simple technique and because of the ease with which the results could be graphically recorded.

The technique of this method, briefly, is as follows: a glass tube with a capacity of 5 cubic centimeters is employed. This tube is graduated in millimeters, each millimeter representing 0.1 cubic centimeter. A syringe, which contains 0.5 cubic centimeter of a 3 per cent solution of sodium citrate, is used to draw 4.5 cubic centimeters of blood from a

vein. The syringe is then emptied into the tube. The position of the sedimenting column is noted every 5 minutes for 30 minutes, and again 15 and 30 minutes later. The observations are recorded on the sedimentation charts (Fig. 1) on which the abscissæ represent the divisions on the sedimentation tube and the ordinates represent the time intervals.

We adhered to the rule followed by Cutler in determining the sedimentation time. The time at which the erythrocytes settle a distance of less than 1 millimeter in 5 minutes is recorded on a chart. This point is the sedimentation time. Thus, the sedimentation time for the diagonal curve shown in Figure 1 is 45 minutes and for the vertical curve 30 minutes. If the sedimentation time is over 30 minutes but less than 60 minutes, the graph is a diagonal curve, if the time is 30 minutes or less, the curve is vertical. Sedimentation is not complete at the end of 1 hour in cases giving horizontal or diagonal lines and, therefore, the sedimentation time is not recorded in these cases.

## REVIEW OF LITERATURE ON SEDIMENTATION TEST IN PREGNANCY

In 1918, Fåhræus (11) was accidentally attracted to the accelerated sedimentation of the erythrocytes in the citrated blood of pregnant women. He found the sedimentation rate often 50 to 100 times more rapid in the pregnant than in the non pregnant.

Friedlander also observed an increased sedimentation in pregnancy (Linzenmeier method). Although he admitted that the test yields no practical results for the diagnosis of pregnancy, he believes that negative findings are of maternal aid in differentiating pregnancy after the fourth month from simple tumors.

Neumann and Doghotti noted a practically normal sedimentation rate in the first 3

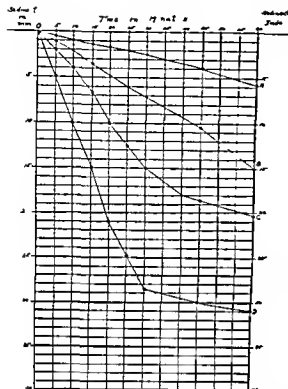


Fig. 1. Graph of the four types of curves obtained by recording the sedimentation in millimeters every 5 minutes up to 30 minutes and again 15 and 30 minutes later. A The horizontal line—a straight line—sedimentation index falling within normal limits (below 10). B The diagonal line—a straight line—sedimentation index beyond normal limits. C The diagonal curve—a curve of gradual descent—sedimentation time of 30 to 60 minutes. D The vertical curve—a curve with a sharp descent—sedimentation index beyond normal limits and sedimentation time of 30 minutes or less.

months of gestation and a steadily increasing rate in the second half of pregnancy.

In a study of 190 patients in all periods of pregnancy, Falta observed an increased rate after the first 3 months. The most rapid sedimentation occurred during the third stage of labor, and the velocity of sedimentation increased during labor even in cases in which high values were already obtained during pregnancy.

Pratucevitch studied the sedimentation test in 41 gravid women. In 20 of these pregnant 6 to 8 weeks, the sedimentation rate varied from 4 to 20 millimeters in 1 hour (normal, 6 to 8 millimeters). The rate was more rapid in the fourth and fifth months of

pregnancy, varying from 15 to 32 millimeters in 1 hour.

Alexander, in a study of 42 gravid women found an increased sedimentation rate in all patients after the third month of gestation. He believed that, with a normal sedimentation time, pregnancy of more than 3 months is very unlikely. Zeckwer and Goodell and Noyes and Corvase have made similar observations.

#### RESULTS OF SEDIMENTATION TEST IN PREGNANCY

The sedimentation tests performed upon 540 women in different months of gestation were analyzed. These women were free from infectious disease and complications of pregnancy at the time of examination.

Table I portrays the general results of the test, whereas Table II subdivides the results according to the months of pregnancy. It is observed from Table I that 536 patients (99 per cent) had an increased sedimentation index in pregnancy. The more rapid sedimentation, as represented by a diagonal curve was noted in 250 patients (46 per cent), while 112 patients (20 per cent) gave the most rapid acceleration, represented graphically by a vertical curve (sedimentation index less than 30).

Table II shows that of the 6 women examined as early as the second month of gestation only 3 showed an increased sedimentation index, the 3 others being normal. It is to be especially noted that none of the patients had a normal rate after the third month. Of the 453 women examined in the sixth month of gestation or later practically 75 per cent showed the marked acceleration represented by a diagonal or vertical curve.

#### RELATION OF SEDIMENTATION TO ANEMIA

It has been pointed out by many authors that the concentration of the erythrocytes alters the sedimentation rate. Rubin and Smith (30), Morns and Rubin (23), Groedel and Hubert, Hubbard and Geiger and others have shown that the sedimentation is slow in polycythæmia and rapid in anemia.

Rubin and Smith found that the lower the hæmoglobin content of the blood, the more

TABLE I—RESULTS OF SEDIMENTATION TEST IN 540 PREGNANT WOMEN

Graph	No of cases	Per cent	Sedimentation index (millimeters)					
			<10	15	20	25	30	35
Horizontal line	4	7	0	0	0	0	0	0
Diagonal line	274	50.7	0	14	61	81	16	2
Diagonal curve	250	46.4	0	0	5	69	155	21
Vertical curve	112	20.7	0	0	0	7	53	47
Total	540							

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TABLE II—SEDIMENTATION RATES ACCORDING TO MONTH OF PREGNANCY

Graph	Month of gestation					Total
	2nd	3rd	4th	5th	6th or later	
Horizontal line	3	2	0	0	0	4
Diagonal line	3	23	15	16	114	174
Diagonal curve	0	1	0	9	110	120
Vertical curve	0	1	0	0	100	102
Total	6	27	20	25	433	540

TABLE III—SEDIMENTATION RATE IN RELATION TO ERYTHROCYTE COUNT

Red blood cells millions per c.c.	Graph					Dixon and vertical curves Per centage
	No. of cases	Horizontal line	Diagonal line	Diagonal curve	Vertical curve	
4 or more	79	2	53	19	5	24 30
3.5-4.0	103	1	71	04	15	120 59
3-3.49	182	0	43	03	45	130 70
Less than 3	85	0	7	44	35	79 91
Total	549					

frequently is increased sedimentation obtained. They hold that this relationship also applies to the red cell count, so that with a decrease in the erythrocyte count there is a proportionate increase in sedimentation, and vice versa. Since, clinically, a marked anemia produces an increased rate of sedimentation, they believe that the volume of red cells (as determined by hæmocrit) exerts an important influence on the reaction under all conditions.

Hubbard and Geiger found that rather slight variations of the normal red cell count apparently produce marked differences in the sedimentation rate.

Schumacher and Vogel and Clauser hold that in anemia there are accompanying changes in the blood which will modify the sedimentation, and that these variations are not to be taken as evidence of inflammation.

Ordinarily, proper allowance has not been made for the fact that a definite anemia co-exists in many inflammatory and other conditions usually associated with a rapid sedimentation. If this test is to be accurately evaluated in various clinical conditions, the effect of blood deficiency *per se* in producing accelerated sedimentation must be distinguished from an increase produced by the existing disease. Although it has been found that the sedimentation rate is increased in pregnancy, the fact that a moderate to a severe grade of anemia is 'normally' associated with pregnancy has been more or less disregarded in sedimentation studies in the gravid state.

We have therefore attempted a parallel study of sedimentation and erythrocyte count during pregnancy and after delivery in the same group of patients.

Table III analyzes the sedimentation rates according to the erythrocyte counts. In accord with our previous study, it is observed that 268 (49.6 per cent) of the women gave counts under 3,500,000. Only 2 of the 461

patients with counts below 4,000,000 showed normal sedimentation, whereas 459 had a sedimentation rate represented graphically by a diagonal line, diagonal curve, or vertical curve. However, of the 79 patients with no anemia (over 4,000,000 cells), 77 gave an increased sedimentation rate, although in 53 of these it was only slightly above normal (diagonal line).

On superficial examination of these results it seems that the erythrocyte count does not materially influence the sedimentation rate. If the patients with a rate equivalent to a diagonal or vertical curve are grouped according to their respective counts, quite different results are obtained (Table III). It is observed that only 24 (30 per cent) of the 79 patients with a normal red cell count had either a diagonal or a vertical curve, whereas the percentage of patients with a rapid sedimentation (equivalent to a diagonal or vertical curve) became considerably higher as the anemia became more marked. Of the 86 patients with a count below 3,000,000, 79 (91 per cent) had a sedimentation velocity equivalent to either a diagonal or vertical curve. Anemia, therefore, probably is a factor in determining the rate of settling of the erythrocytes in pregnancy as in other pathological conditions.

#### RELATION OF LEUCOCYTE COUNT TO SEDIMENTATION RATE

To determine the relationship between the leucocyte count and the sedimentation rate in



TABLE IV — SEDIMENTATION RATE IN RELATION TO LEUCOCYTE COUNT

White blood cell count per c. cm.	No. of cases	If normal	Diagonal	Diagonal	Vertical	Total and percent of total
		100-150	150-200	200-250	250-300	total curves
15,000 or more	26	0	2	10	5	22 (92)
10,000-14,000	120	0	11	61	24	85 (71)
Less than 10,000	394	4	112	275	45	255 (64)
Total	540					

TABLE V — FIBRINOGEN CONTENT IN PREGNANCY, ACCORDING TO GRAVITY

Month of pregnancy	No. of cases	Average percent of fibrinogen
Second	2	0.33
Third	1	0.42
Fourth	3	0.35
Fifth	4	0.39
Sixth	4	0.45
Seventh	20	0.45
Eighth	7	0.5
Ninth	7	0.49
Tenth	15	0.5

Note that the fibrinogen percentage after the fifth month of pregnancy is considerably higher than prior to the fifth month.

pregnancy the various curves obtained have been arranged in Table IV according to the leucocyte counts at the time of examination. This table shows that 24 (92 per cent) of the 26 patients with leucocytosis (15,000 leucocytes per cubic millimeter) gave a very rapid sedimentation rate (equivalent to a diagonal or vertical curve) whereas the percentage of patients exhibiting this rapid sedimentation decreased as the number of leucocytes diminished. It may therefore be assumed that an increased number of leucocytes can also influence the sinking time of the erythrocytes.

#### THE BLOOD SEDIMENTATION VELOCITY IN THE PUERPERIUM AND LATER

Friedlander noted that a rapid sedimentation occurred in the puerperium as well as during pregnancy. The sedimentation rate however diminished after the tenth day of the puerperium, returning to normal in about 4 weeks provided the lying in period is not complicated with infection.

According to Linzenmeier and Falta an inhibition in the velocity of sedimentation occurs 10 days after labor. This however, is subject to fluctuation due probably to the variation in the healing processes of the endometrium. These authors state that the sedimentation reaction returns to the normal of the non pregnant woman after the third week.

Falta emphasizes that puerperal infections, lochiometra, hemorrhage and perineal lacerations cause a delay in return of the sedimentation rate to the value of the nonpregnant state.

The studies of Neumann disclosed that the sedimentation velocity starts to increase immediately after separation of the placenta and continues during the puerperium reaching its maximum on the seventh day. He noticed a further increase in the rate during the puerperium even in those patients who had shown

a very rapid sedimentation during pregnancy. He attributes this to re-absorption processes occurring in the uterus. This author investigated the further course of the sedimentation reaction in 75 patients during a period of 3 to 11 weeks after delivery. He found that in 34 cases (72 per cent) the rate returned to normal within 5 to 7 weeks after delivery, and he believes that a pronounced parallelism exists between the sedimentation reaction and the clinical processes of involution.

The sinking time of the red blood cells in the 540 patients examined during pregnancy, was again determined in the puerperium. This examination revealed that the increased velocity persisted for 10 days after delivery.

In order to ascertain how soon after labor the sedimentation rate returned to normal 100 patients having a sedimentation index of between 30 and 45 during pregnancy were re-examined at various intervals within 6 months. Eight patients examined 4 weeks after delivery gave a sedimentation rate equivalent to a diagonal line whereas the 92 remaining after the first month, exhibited slow sedimentation with an index of 6 to 10 millimeters.

Of the 100 patients studied 78 had an erythrocyte count below 3,500,000. On re-examination within 6 months after delivery all had gained between 200,000 and 500,000 red cells, 72 having reached the 4,000,000 mark. From these results it seems that the increased number of corpuscles had been an important factor in causing the delayed sedimentation during the postpuerperal period.

#### DISCUSSION

Various explanations have been advanced as to the cause of the sedimenting property of the red blood cells.

Cordua and Hartman observed that a byperinosis, or an increased fibrin (fibrinogen) content of the plasma, existed in all conditions with acceleration of sedimentation. Bruch saler found that the blood plasma, during the last weeks of gestation and immediately after delivery, showed a marked increase in the content of fibrinogen, as compared with that in women with normal sedimentation. From this observation, he concluded that fibrinogen is the chief bearer of the properties which hasten sedimentation.

Fabracus (10, 11) and Linzenmeier favor an electrophysical explanation for the increased sedimentation in infections.

Mikulicz Radecki, Risse, and Meeker believe that the phenomenon of sedimentation is due to the instability in the ratio of the albumin and globulin fractions of the serum. They found a decrease in the albumin fractions and an increase in the globulin and fibrinogen elements in cases with rapid sedimentation.

Gram analyzed the fibrin content of 542 plasmas and observed an increase of fibrin in all infectious diseases, cancer, nephritis, and pregnancy. The mean value of the fibrin percentage per 100 cubic centimeters of plasma in normal women was 0.79 per cent. In simple anemia he found the fibrin percentage in the plasma to be normal. In pregnancy he nearly always found a moderate to a severe grade of anemia and an increased percentage of fibrinogen. The average fibrinogen content in pregnancy, as determined by Gram, is listed in Table V.

On the basis of these observations he concluded that the sedimentation depends on two factors: (1) cell volume percentage and (2) fibrin (fibrinogen) percentage in the plasma. The tendency to hyperinosis begins early in pregnancy but does not always reach beyond the upper boundary of the normal before the fifth or sixth month. Gram considered the increased fibrinogen as being an expression of the introduction of foreign proteins in the blood and believed that the fibrinogen brings about the accelerated sedimentation by causing an agglutination of the erythrocytes which facilitates their sedimentation.

These observations are important in view of the fact that we found a marked increase in

the sedimentation rate of the blood in 362 pregnant women. The rapid sedimentation, we believe, depends on the fibrinogen content of the plasma, although the existence of anemia and leucocytosis may play a role in altering the degree of rapidity.

The question now arises as to the significance of the physiological acceleration of sedimentation in pregnancy. It is generally recognized that fibrinogen, existing in solution in the blood, is the essential factor in the coagulation of the blood. A slow sedimentation in pregnancy indicates that the fibrinogen content, for some reason, has not changed from that of the non pregnant state, or else is diminished. The sedimentation value may, therefore, be considered as an index of the coagulating property of the blood. A prolonged or a delayed sedimentation forebodes a delay in coagulation at the time of expulsion of the fetus and placenta, with the likelihood of postpartum hemorrhage. Furthermore, a patient with a severe grade of anemia and a slow sedimentation in pregnancy would be extremely likely to develop excessive bleeding during or after labor.

The fact that a rapid sedimentation is almost always associated with normal pregnancy after the third month may aid in differentiating a myomatous uterus from a pregnant one, since an uncomplicated myoma does not alter the sedimentation rate of the blood.

#### SUMMARY

1 The blood sedimentation test was performed upon 540 gravid women in the different periods of pregnancy and in the puerperium. In 536 patients, sedimentation occurred more rapidly than in the normal non pregnant patient.

2 Of the 453 women examined in the sixth month of pregnancy or later, 75 per cent showed a marked acceleration of sedimentation equal to either a diagonal or vertical curve.

3 Of 79 patients with an erythrocyte count of 4,000,000 or more, 24 (30 per cent) gave either a diagonal or vertical curve, whereas, of the 86 patients with a severe anemia (counts below 3,000,000), 79 (91 per cent) had a sedimentation velocity equivalent to either a diagonal or vertical curve.

4 Of the 26 patients having a high leucocyte count (15,000 or over), 24 (92 per cent) showed a very rapid acceleration, whereas 64 per cent of the 394 patients having a leucocyte count below 10,000 gave a sedimentation rate equivalent to a diagonal or vertical curve

5 The same sedimentation rates as occurred during pregnancy were maintained during the first 10 days after delivery

6 The sedimentation reaction and the erythrocyte counts returned to the normal of the non pregnant woman in practically all the women examined within 6 months after delivery Of the 100 women examined within 6 months after labor 92 exhibited a slow sedimentation, with an index of 6 to 8 millimeters

### CONCLUSIONS

1 Sedimentation of the erythrocytes in pregnancy is considerably more rapid than in the non pregnant state

2 This acceleration is probably primarily dependent upon the increased fibrinogen content of the plasma and secondarily on the anæmia and leucocytosis physiologically present in pregnancy

### BIBLIOGRAPHY

- 1 ALEXANDER M E Clinical and experimental observations on blood Med J & Rec 1924 cxiv 549-552
- 2 BAER JOSEPH and REIS R A Sedimentation test in obstetrics and gynecology Surg Gynec & Obst 1923 xl 691-696
- 3 BLAND P B GOLDSTEIN L and FIRST A Secondary anemia in pregnancy and in the puerperium In press
- 4 BRUCHSALER S Ueber Beziehungen zwischen der Blutkörperchen senkungsgeschwindigkeit und dem Fibrinogengehalt des Blutes Zentralbl f Gynaek 1927 li 2010-2014
- 5 CLAUSER F I fenomeni fisico-chimici nella sedimentazione degli eritrociti e valore clinico del processo in ostetricia e ginecologia Ann di ostet e ginec 1913 xlv 181-212
- 6 CORDA R and HARTMAN H Gerinnungs- und Senkung-beschleunigung des Blutes Klin Wchnschr 1926 v 2300-2311
- 7 CUTLER J The graphic presentation of the blood sedimentation test Am J M Sc 1916 cxviii 882-901
- 8 Idem The graphic method for the blood sedimentation test Am Rev Tuberc 1929 xvi 544-558
- 9 DOGLIOTTI V La reazione di Fahræus con particolare riguardo alle sue applicazioni in ostetricia e ginecologia Folia gynæc 1926 xxiii 411-442
- 10 FAHRÆUS R Om hæmagglutinationen særskilt med hænsyn till havandeskapet och möjligheten att diagnostiskt utnyttja d-asamma Hygiea 1918 vii 369

- 11 Idem The suspension stability of the blood Acta med Scand 1921 lv 1-228
- 12 Idem Ueber die Ursachen der verminderten Suspensionstabilität der Blutkörperchen während der Schwangerschaft Biochem Ztschr 1918 lxxx 355-361
- 13 FALTA B Ueber die Verwendung der Senkungsgeschwindigkeit der roten Blutkörperchen in der Geburtshilfe und Gynaekologie Zentralbl f Gynaek 1924 xlviii 1478-1483
- 14 FRIEDLANDER B Blood sedimentation test as an aid in diagnosis of surgical affections Am J Obst & Gynec 1914 vii 123-144
- 15 FROCH H L Sedimentation test in obstetrics and gynecology Am J Surg 1926 xl 121-123
- 16 GRAM H C On the causes of variations in the sedimentation of the corpuscles and the formation of the crusta phlogistica (the buffy coat) on the blood Arch Int Med 1911 xxviii 312-330
- 17 GREISCHNER E M Blood sedimentation in normal men and women Am J M Sc 1917 cxviii 338
- 18 GRODEL F M and HURFERT G Die Blutkörperchen senkungsgeschwindigkeit bei inneren Erkrankungen besonders bei Kreislaufstörungen Ztschr f Klin Med 1923 cxvii 37-45
- 19 HUBBARD R S and GEIGER H B Anæmia as a factor in the sedimentation time of erythrocytes J Lab & Clin M 1919 x 321-323
- 20 LINZENMAYER G Klinisches Sammelreferat ueber die Blutkörperchen senkungsgeschwindigkeit Deutsche med Wchnschr 1912 xlviii 1023-1024
- 21 MEYER D O Theoretical explanations of erythrocyte sedimentation Clifton Med Bull 1923 xi 1
- 22 MULLICH RADECKI Roentgenbestrahlung und Blutkörperchen senkungsgeschwindigkeit Arch f Gynaek 1921 cxx 187-193
- 23 MORRIS W H and REBAN E H The sedimentation reaction of erythrocytes Clinical applications and a macromethod J Lab & Clin M 1926 xi 1043
- 24 NEUMANN H O Die Senkungsgeschwindigkeit der roten Blutkörperchen unter der Geburt und im Wochenbett Zentralbl f Gynaek 1925 xlii 536
- 25 NOYES L H and CORVESE A The significance of blood sedimentation time in gynecology and obstetrics Boston M & S J 1916 cxv 891-896
- 26 PRATOLIVITICH M A Clinical observations on the rate of sedimentation of erythrocytes in gynecology and obstetrics Bielorr Med Duma 1927 iii 16
- 27 RISSE Ueber einige Blutveränderungen während Roentgen und Radium wirkung Arch f Gynaek 1923 cxx 181-187
- 28 RUBIN E H The clinical value of the erythrocyte sedimentation reaction in surgery Surg Gynec & Obst 1916 lvi 63-66
- 29 Idem Relation of the erythrocyte sedimentation reaction to the ability of flocculation of the plasma and serum Arch Int Med 1916 xxxviii 848-860
- 30 RUBIN E H and SMITH N Relation of hemoglobin cell count and cell volume to the erythrocyte sedimentation reaction Arch Int Med 1917 xxxix 303-314
- 31 SCHUMACHER P and VOGEL W Die Bedeutung der Blutkörperchen senkungsgeschwindigkeit fuer die Diagnostik gynäkologischer Erkrankungen Arch f Gynaek 1923 cxx 1-7-13
- 32 WESTERLUND A Die Senkungsreaktion Ergebn d inn Med u Kinderh 1924 xxvi 1-733
- 33 ZECKAWEY I T and GOODALL H The sedimentation rate of erythrocytes Am J M Sc 1923 cxv 209-216

THE EFFECT OF SERUM FROM PREGNANT WOMEN ON THE  
ESTRUAL CYCLE OF THE GUINEA PIGA PRELIMINARY REPORT UPON THE POSSIBILITY OF ITS USE AS A TEST FOR PREGNANCY<sup>1</sup>

G LOMBARD KELLY M D AND LOREE FLORENCE M D AUGUSTA GEORGIA

IT has been definitely shown that the corpus luteum hormone has an inhibitory influence on the oestrous activities in certain lower forms, notably the guinea pig (3) and the rat (5). More recent investigations have confirmed this work.

Papanicolaou (3) writes of the antagonistic properties of the female sex hormone (oestrin) and the corpus luteum hormone, and Parkes has advanced the idea that these two endocrine products of the ovary are antithetically opposed to each other and that during pregnancy the corpus luteum hormone is in the ascendancy until the time of parturition. It is a well known fact that guinea pigs, rats, and mice come into oestrus immediately after parturition and will copulate at that time.

By injecting female sex hormone (oestrin) into white mice, Parkes and Bellerby found they could prevent conception or terminate pregnancy at any stage. The addition of the oestrus producing hormone upset the balance between the two hormones and threw the genital tract into a state incompatible with the normal continuance of pregnancy. In view of the recent contributions of Corner and Allen on the functions of the corpus luteum hormone it is easy to comprehend how an ascendancy of oestrin could prevent conception. These authors have given experimental proof that the corpus luteum hormone exerts an essential influence on the mucosa of the uterus in its preparation for the nidation of the fertilized ovum.

Margaret Smith tested the effects of similar injections in white rats and found she could interrupt pregnancy up to the fifth day but not thereafter although she injected as high as 80 rat units into a single animal. We have been carrying on a like study of the guinea pig, in which we have been able to prevent conception and, with very large doses, to interrupt the normal course of pregnancy at any stage. This work has not yet been completed.

On the premise that during pregnancy there is an excess of corpus luteum hormone over the oestrus producing hormone and on the basis of the knowledge that the corpus luteum hormone inhibits oestrus, we undertook to ascertain if injections of serum from women known to be pregnant would inhibit oestrus in the guinea pig. This animal has a very definite and clear cut oestrus cycle (8) and by means of vaginal smears the exact stage of heat can easily be ascertained.

A group of animals was selected and their cycles determined over a period of several weeks. Only animals that were healthy and regular were used. They were divided into three groups, the first to be used as test animals and the second and third as controls. The second group received injections of serum from non pregnant women and the third group injections of a 1 per cent peptone solution.

The blood was collected in test tubes and the clots broken with a sterile glass rod. After about 24 hours the serum was transferred to sterile 1 ounce vaccine bottles with rubber stoppers and placed in the ice box. It was drawn from the bottles in the usual aseptic manner when injections were made.

In all cases the injections were begun on the ninth day of the cycle, which averages between 15 and 16 days. This was in accordance with the observations of Papanicolaou (3) that injections begun at this time were more effective than when started later in the cycle. The injections were given daily for 4 days and the total quantity varied from 10 cubic centimeters to 20 cubic centimeters. We began with 2 cubic centimeters as a rule and increased the dose each day. Many of the injections were made intraperitoneally, while others were made subcutaneously in the flanks.

The results in the first group showed a delay in the onset of oestrus, the postponement

<sup>1</sup>Contribution No. 5, Series B, from the Department of Anatomy of the Medical Department of the University of Georgia. This investigation has been aided by a grant from the National Research Council through its Committee for Research in Sex Problems.

TABLE I—ANIMALS RECEIVING SERUM FROM PREGNANT WOMEN

Animal number	Cycle days	Injections	Total c.c.m.	Delay days
1140	14	4	10	8
1142	16	4	20	5
1143	14 5	4	14 5	7
1149	16	4	12	3
1181	14	4	14	5
1185	14	4	14	7
1189	16	4	14	5
1188	14	4	14	7
1193	14	4	13	7
Total animals 9	Average delay		6 days	

TABLE II—ANIMALS RECEIVING SERUM FROM NON-PREGNANT WOMEN

Animal number	Cycle days	Injections	Total c.c.m.	Delay days
1131	13	4	20	0
1032	15	4	20	2
1183	16	4	14	0
1186	14	4	14	1
1190	14	4	14	1
Total animals 5	Average delay		0.8 days	

varying from 3 to 8 days, with an average of 6 days (Table I)

According to Papanicolaou (3) a corpus luteum unit is defined as that quantity necessary to postpone ovulation in the normal guinea pig for 1 day. On this basis the average quantity of serum used with this group of animals contained 6 units of free corpus luteum hormone. By free, we mean in excess of the amount required to neutralize the female sex hormone, assuming that these hormones can offset each other in such a manner.

In the second group of 5 animals serum from non pregnant women was injected each one receiving a total of from 12 cubic centimeters to 20 cubic centimeters over a period of 4 days in increasing dosage. In this group the onset of oestrus was postponed from 0 to 2 days, the average being 0.8 day. Since the cycle of a given animal may vary 1 day from one period to the next this delay lacks significance (Table II).

In the third group of 4 animals each one received a total of 20 cubic centimeters of 1 per cent peptone solution in 4 days. In none of the members of this group was there any delay in the onset of oestrus (Table III).

It is worthy of note that the average length of the oestral cycle in days is shorter in our animals than the averages of Stockard and Papanicolaou (15.75) and Selle (15.87). Whether

TABLE III—ANIMALS RECEIVING 1 PER CENT PEPTONE SOLUTION

Animal number	Cycle days	Injections	Total c.c.m.	Delay days
1007	15	4	20	0
1031	15	4	20	0
1004	15	4	20	0
1156	15	4	0	0
Total animals 4	Average delay		0 days	

this is due to the warmer climate, we cannot say, but the cycles of our animals were determined very carefully over a number of periods by the vaginal smear method and we believe them correct. It is interesting also to note that, whereas the age at which female guinea pigs reach sexual maturity is given as about 3 months, the majority of ours have their first oestrus somewhat earlier, some when less than 2 months old.

Another point that should be noted is that we calculated our cycles from onset to onset (that is, from first stage to first stage), whereas Papanicolaou in defining a corpus luteum unit calculated from ovulation to ovulation, which occurs at the junction of stages 2 and 3 of oestrus as shown by the vaginal smear method. This difference in method of calculation would not give any discrepancy in days, however, since the same starting and ending points were used in each case.

In this work we have not as yet made any effort to ascertain whether the effects vary if the serum is obtained from women in early, middle or late pregnancy. Our main purpose was to determine if serum from women known to be pregnant would cause a postponement of oestrus in the guinea pig. Our next step will be to have serums from unknown sources submitted in a large series of cases so that we can check the efficiency of the method in diagnosing pregnancy.

If this method should prove dependable for this purpose it would require for its use a colony of female guinea pigs with an attendant to take smears daily from all animals with open vaginas, so that each individual cycle would be definitely known. The oestrus of the guinea pig vagina cicatrizes between heat periods (and during pregnancy)<sup>4</sup> and opens again at oestrus (for about 4 days). This is a time saving factor since it can be taken for

granted that no animal with a closed vagina is in heat and no smear need be taken under such circumstances

The time required for a report in any case would vary from a week to 10 or 12 days depending upon whether the result is negative or positive. If negative, the vagina would open in a week or less from the beginning of injection (ninth day of cycle). If positive the result could be presumed on the tenth day after beginning injections and should be certain by the twelfth.

Some of our animals succumbed to the injections of serum. It would therefore be in order to determine if injection of smaller as well as the larger quantities of serum from pregnant women will postpone oestrus. In practice, it might be advisable to use two animals for each test, in case one should die. The quantity of blood required for the test would average about 50 cubic centimeters.

We found that animals which had received serum once could not be used again as they promptly died from anaphylaxis when the second series of injections was begun.

Of course, it cannot be taken for granted that the corpus luteum hormone in the serum from pregnant women is the only factor causing the postponement of oestrus; there may be others. Hormones from the fetus or the placenta must be considered. However, this

investigation shows there is a qualitative difference between the serums of pregnant and non pregnant women and that this difference can be detected by a method of biological assay that may be turned to a practical advantage, namely, the diagnosis of pregnancy in the human. This paper is written in the nature of a preliminary report and the refinement of the method lies in the future.

#### BIBLIOGRAPHY

1. CORNER C W and ALLEN WILLARD M. Physiology of the corpus luteum (I II III). *Am J Physiol* 1928 LXXXI 1929 LXXXVIII
2. KELLY and PAPANICOLAOU. The mechanism of the periodical opening and closing of the vaginal orifice in the guinea pig. *Am J Anat* 1927 XL Nov
3. PAPANICOLAOU G N. A specific inhibitory hormone of the corpus luteum. *J Am M Ass* 1926 LXXXI May 8
4. PARKES A S and BELLERBY C W. Studies on internal secretions of the ovary: effects of injection of oestrus producing hormone during pregnancy. *J Physiol* 1926 LXII 145-155
5. PERLEYRA ARMANDO. Inhibition of oestrus and the experimental production of deciduomas in the rat by extracts of corpora lutea of pregnancy. Abstracted in *Anat Rec* 1928 Mar 25
6. SELLIE RAYMOND M. Changes in the vaginal epithelium of the guinea pig during the oestrus cycle. *Am J Anat* 1922 XXX
7. SMITH MAROARETT. Interruption of pregnancy in the rat by injection of ovarian follicular extract. *Bull Johns Hopkins Hosp* 1926 XXVI 203-214
8. STOCKARD and PAPANICOLAOU. The existence of a typical oestrus cycle in the guinea pig. *Am J Anat* 1917 XXII Sept

## THE FUNDAMENTAL OPERATIVE TREATMENT OF INGUINAL HERNIA

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**T**HE initial paper of this series (8) dealt with the demonstration of a true inguinal sphincter, formed around the abdominal os of the inguinal canal by circular fibers of the internal oblique and transversalis muscles. The data submitted in the former article also indicated that this sphincter is voluntary in character and normally functions to protect the internal opening of the inguinal canal, first, by a constant state of tonus and second, by voluntary reflex contractions whenever the intraperitoneal pressure is, for any reason, increased. Further, evidence was presented toward the proof that the usual method of production of an indirect hernia is by the extrusion of a peritoneal wedge into the inguinal canal through an increasingly insufficient internal inguinal sphincter, the prime moving factor being the piston valve like action of the vacillating intraperitoneal pressure. To sum up, anatomical, empirical, and experimental evidence was adduced to prove that the primary etiological factor in the causation of inguinal hernia is an insufficiency or paresis of the internal inguinal sphincter and that any procedure directed at the operative cure of the hernia must have as its basis the correction of this fundamental sphincteric failure. In the present article, the details of such an operative procedure will be given. It may be well, however, with the above conception in mind, first to review the imperfections inherent in the current hernia operations in order to clarify and emphasize such departures in technique as will later be advocated. Accordingly, the following brief account of the procedures in current use for the operative cure of inguinal hernia may be found explanatory and convenient.

### CURRENT OPERATIONS

Among the most important and typical of these are the Bassini, Ferguson and Halsted any of which may be modified or combined with the Andrews method of closure.

Bassini originally emphasized the high ligation of the sac, transplantation of the cord, and adequate repair of the posterior wall of the inguinal canal. In the modified Bassini, as now frequently employed (10), an incision through skin and fascia is made parallel to, and one half inch above, Poupart's ligament. The aponeurosis of the external oblique is next divided longitudinally, so that an adequate inferior flap is left. The hernial sac is then separated, emptied, incised, ligated proximally, severed, and removed. With the cord retracted laterally, the internal oblique and transversalis above, and the conjoint tendon below, are sutured to the shelving edge of Poupart's, the region of the internal ring being made "snug" by a Coley suture above the entrance of the cord. This structure is then transplanted and covered by imbricating the two flaps of external oblique aponeurosis. The skin wound is closed by a subcuticular stitch.

Ferguson attempts a more extensive repair of any deficiency of the internal ring. He employs a higher incision and separates the two flaps of the external oblique aponeurosis up to the level of the anterior superior spine. He then sutures the separated fibers of the internal oblique and transversalis back to their defective origin from the upper portion of Poupart's ligament, and, if necessity arises, may actually transplant a higher portion of these muscles to the region around the entrance of the cord. In case of complicating direct hernia, he advocates transplantation even of the rectus and its suture to the lower portion of Poupart's. The cord is not disturbed in the above technique.

Halsted (Johns Hopkins) employs a flap of cremaster to strengthen the posterior wall of the canal and to bridge any gap posteriorly between the internal muscles and the inguinal ligament. Mattress sutures are employed for the union of the cremaster fascia and muscle with the posterior aspect of

the transversalis and internal oblique. In his operation also, as in the Ferguson, the cord is not disturbed, nor is especial attention paid to the internal ring. Closure is effected by the overlapping of the aponeurotic flaps.

Other modifications of technique have at various times been advocated. Thus, Halsted originally advanced an operation, which has been lately revived and in which the cord was transplanted external to the aponeurosis. Again, Watson recommends lateral displacement of the cord out of the line of deep suture and enforces this by stitching the external oblique aponeurosis to the internal muscle immediately lateral to the new position of the cord. Scott places the cord under the upper half of the aponeurotic sutures and over the lower half, thus permitting an adequate closure of the external ring. Finally in the Andrews' method of closure, sufficient lower aponeurotic flap is left so that a secure "double breasted" imbrication of the two flaps may be effected, the upper internal flap being sutured either anterior or posterior to the cord.

Every one of the above operations presents points of surgical excellence. As has been indicated, however there are certain theoretical and practical defects inherent in many of the procedures. To summarize briefly:

1. Muscle tissue, when so transplanted as to act obliquely to the direction of its fibers is not only ineffective but is soon rendered practically functionless through fibrous degeneration.

2. Adequate anatomical union as proved by Cavell, cannot occur unless fascia to fascia and muscle to muscle suture is employed. Ultimately any other method of approximation will be found to result in unsatisfactory fusion.

3. Any attempts at the repair of the internal ring either by oblique muscle transplants or by pinching the fascia and muscles about the internal os with sutures must remain inadequate, since for both of the reasons mentioned, adequate functional restoration of the muscles cannot ensue. Transplantation of the internal oblique, incidentally, must necessarily obviate the valve like clos-

ing action which this muscle exerts on the inguinal sphincter.

4. Fascial transplants, as frequently employed, can evidently not have any supportive muscular action, and when once loosened must remain permanently so.

Most important of all, however, is the consideration that, since the basic etiological factor in the causation of inguinal hernia is an insufficiency of the internal inguinal sphincter rational operative procedures must have as their prime object the correction, in so far as possible, of that insufficiency and need only secondarily be concerned with the subsequent closure of the inguinal canal. Accordingly, the irrationality of such procedures as the suturing of the internal os to the peritoneum, or the deliberate division of the former, as employed by Davies, is obvious.

#### RESULTS OF THE PRESENT OPERATIONS

The validity of the above objections may be appreciated by considering the results that have been and are being obtained by the use of the current operations. A review of the literature reveals the fact that the percentages of hernial recurrence, as reported by capable operators, range from 6.5 to as high as 17.5 per hundred cases. Thus, of 978 cases of inguinal hernia traced by Erdmann, hernia recurred in 74. In the French navy, the recurrence of inguinal hernia following operation as reported by Oudard and Jean, reached 10 per cent. When the inguinal protrusion is associated with direct hernia, the percentage of recurrence, as estimated by Watson, is from 10 to 20, even in the hands of the most experienced operators. Even these comparatively high figures are misleading, in that, in many of them, the recurrences represent only those patients who voluntarily return to the same clinic for reoperation, or who have reported a recurrent hernia large enough to be diagnosed by the patient himself. Obviously, therefore, if all cases were followed for a sufficient length of time (5 to 10 years) the percentage of recurrence would be found to be considerably higher than at present realized.

Significant also is the fact recorded by Watson "Oblique inguinal hernias most



frequently recur through the opening left for the cord or a weak spot in muscle or fascia." This statement alone would indicate that the chief weakness of the older operations is their utter disregard of the prime functional importance of the muscular sphincter about the internal os and their inefficiency in the repair of this sphincter.

### THE TECHNIQUE

With the above considerations in mind, the author has devised, and has practiced, certain modifications of technique that have been productive of entirely satisfactory results. In effect his procedure is as follows:

After the usual Bassini incision a grooved director is inserted between the pillars of the external ring, and the aponeurosis of the external oblique split in the direction of the internal os. If the operator intends subsequently to employ an Andrews closure it is best that this splitting be done above the line of the cord, so that a sufficient inferior aponeurotic flap be left for imbrication. Retraction now reveals the full extent of the canal. The sac is separated, emptied, ligated, and excised in the orthodox manner—high ligation of the sac (since it removes the paralyzing peritoneal cone) being one of the most commendable features of the older operations. The following important steps in the technique are characteristic of the procedure and now require careful attention.

The internal inguinal sphincter is identified and its relative insufficiency determined. Any defect is then corrected by displacing the cord to the upper inner quadrant of the ring, and so shortening and suturing (No. 1 chromic catgut) the lower outer fibers of the sphincter as best to restore the snugness and tonicity of the muscular ring. It is essential to note that these sutures in no way involve the shelving edge of Poupart's, but serve only to bring together the deficient lower outer portion of the inguinal sphincter. It is also essential that, throughout all of the manipulations no injury be done to the ilio inguinal or iliohypogastric nerves, since trauma

tization of their motor fibers (8) may defeat the purpose of the entire operation by producing degenerative paresis of the internal inguinal sphincter.

If this technique has been followed carefully, the manner of subsequent closure of the canal and of the incision may be left to the choice of the operator—the variations of procedure, in my opinion, being of comparatively minor importance. In most instances, the anterior or posterior Wyllis Andrews' closure, as employed by the present author, will be found entirely satisfactory.

### CONCLUSIONS

It may be noted that all of the steps of the procedure here advocated are based upon sound anatomical and surgical principles, i.e. the operation is physiologically rational and proceeds in a definite manner to correct a definite etiological defect. In effect, the time of operation is shortened, handling of the parts is reduced to a minimum, excess catgut is avoided and the procedure redispposes all of the involved structures into the best (i.e., their original) muscle and fascial planes. Finally, the relative simplicity of its technique renders the operation capable of wide applicability.

### BIBLIOGRAPHY

1. ANDREWS, E. W. Imbrication or lap joint method a plastic operation for hernia. *Chicago M Rec* 1895 ix 6 77.
2. CAVELL, ERNEST. Recent advances in surgery of hernia. *Lancet* 1 478-483.
3. EDMUNDS, S. Inguinal hernia in the male. *Ann Sur* 1923 LXVIII 171 180.
4. FERGLSON, A. H. Modern operation for hernia. *Cleveland Press* 1901.
5. HALSTED, W. L. The radical cure of inguinal hernia in the male. *Johns Hopkins Hosp Bull.* 1893 ix 17 4.
6. HALSTED, W. L. The cure of the more difficult as well as the simpler inguinal ruptures. *Johns Hopkins Ho p Bull.* 1903 xiv 08 214.
7. MACGREGOR, W. W. The demonstration of a true inguinal sphincter and its rôle in hernia. *Sur Gynec & Obst* 19 9 xlix 510.
8. OLDARD and JEAN, G. Hernies inguinales recidivées. *Rev de chir Par* 1921 ix 143 180.
9. SCOTT, A. C. The radical cure of inguinal hernia. *Texas State J Med* 1910-20 xv 56.
10. WATSON, L. F. Hernia. *St Louis C V Mosby Company* 1924.

THE VALUE OF INDWELLING URETERAL CATHETERS IN URINARY SURGERY<sup>1</sup>

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SINCE urinary stasis has been recognized as the leading etiological factor in the pathogenesis of all pathological conditions of the kidney and of the whole upper urinary system, the value of the ureteral catheter in relation to diagnosis and treatment is beyond question. Its use has been essential and indispensable, since it combines the procedures of cystoscopy, urography, and roentgenography in routine examinations in diseases of the genito-urinary tract.

The marvelous clinical experience of former days is concentrated in this triple procedure of modern urology, namely, catheterization of the ureters, direct observation of the bladder and urography. Without accomplishing these three elemental procedures in a given case, we would remain in the dark.

Nitze, in 1894, devised the first practical cystoscope. Albarran, in 1897, introduced the ingenious modification that made the catheterization of the ureters possible and later in 1906, Volker and Lichtenberg devised the injection of an opaque medium into the kidney pelvis, for the purpose of pyelography. Each one of these procedures complements the other, they constitute the three foremost steps of the most brilliant era in the development of accurate diagnosis in modern urology.

However, it is my purpose to discuss only the value and the use of the ureteral catheter—particularly of the indwelling ureteral catheter, so called ureteral catheter *in situ*, *sonde a demeure*—retentive or fixed in place in the kidney pelvis after catheterization of the ureter has been accomplished and after the removal of the cystoscope.

I will endeavor in this presentation, to bring to view in a practical way, when and how a ureteral catheter should be used, reporting my personal experience with a few interesting cases, in which I have had most striking and satisfactory results, calling attention, at the same time, to the convenience and great

TABLE I—THE USE AND VALUE OF INDWELLING URETERAL CATHETER BEFORE OPERATION

## Diagnosis

- 1 In all cases of kidney pathology
- 2 In lesions of the ureter
- 3 To exclude stone shadows and anomalies of the upper urinary tract
- 4 For the purpose of pyelography and roentgenogram studies
- 5 To estimate renal function

## Treatment

- 1 To secure drainage of kidney pelvis in cases of infection and retention
  - 1 Pyelitis
  - 2 Pyelonephritis
  - 3 Hydronephrosis
  - 4 Pyohydronephrosis
- 2 To dilate the ureter
  - 1 Stricture
  - 2 Kinks
  - 3 Stone
- 3 Renal colic
- 4 In so called idiopathic hæmaturia
- 5 In cases of anuria or uremia
- 6 In cases of infection of the kidney pelvis including pyelitis of pregnancy and pyelonephroureteritis of infancy
- 7 In cases of infected horseshoe kidney
- 8 In polycystic kidney disease
- 9 In ascending infection as in urinary reflux
- 10 For the purpose of kidney pelvis lavage when infection and fever are present due to lack of drainage
- 11 After pyelography if the pelvis does not empty in 10 minutes to relieve pain and secure drainage

importance of this simple procedure in three essential groups, namely, before, during, and after operation. I will attempt to illustrate briefly the striking results and the very great convenience of its use, not only to urologists who are well aware of its benefits, but for the purpose of popularizing this procedure among clinicians, surgeons, and general practitioners (Table I).

Before operation the fixed ureteral catheter is used first of all for the purpose of diagnosis and therapeutic treatment. It serves to collect specimens from each kidney pelvis for microscopical and bacteriological examinations and to determine renal function in regard to urea excretion and color dye elimination. Also, it

frequently recur through the opening left for the cord or a weak spot in muscle or fascia." This statement alone would indicate that the chief weakness of the older operations is their utter disregard of the prime functional importance of the muscular sphincter about the internal os, and their inefficiency in the repair of this sphincter.

### THE TECHNIQUE

With the above considerations in mind the author has devised, and has practiced certain modifications of technique that have been productive of entirely satisfactory results. In effect his procedure is as follows:

After the usual Bassini incision a grooved director is inserted between the pillars of the external ring and the aponeurosis of the external oblique split in the direction of the internal os. If the operator intends subsequently to employ an Andrews' closure it is best that this splitting be done above the line of the cord, so that a sufficient inferior aponeurotic flap be left for imbrication. Retraction now reveals the full extent of the canal. The sac is separated, emptied, ligated and excised in the orthodox manner—high ligation of the sac (since it removes the paralyzing peritoneal cone) being one of the most commendable features of the older operations. The following important steps in the technique are characteristic of the procedure and now require careful attention:

The internal inguinal sphincter is identified and its relative insufficiency determined. Any defect is then corrected by displacing the cord to the upper inner quadrant of the ring and so shortening and suturing (No. 1 chromic catgut) the lower outer fibers of the sphincter as best to restore the snugness and tonicity of the muscular ring. It is essential to note that these sutures in no way involve the shelving edge of Poupart's but serve only to bring together the deficient lower outer portion of the inguinal sphincter. It is also essential that, throughout all of the manipulations no injury be done to the ilio inguinal or iliohypogastric nerves, since trauma-

tization of their motor fibers (8) may defeat the purpose of the entire operation by producing degenerative paresis of the internal inguinal sphincter.

If this technique has been followed carefully, the manner of subsequent closure of the canal and of the incision may be left to the choice of the operator—the variations of procedure, in my opinion being of comparatively minor importance. In most instances, the anterior or posterior Wylye Andrews' closure, as employed by the present author, will be found entirely satisfactory.

### CONCLUSIONS

It may be noted that all of the steps of the procedure here advocated are based upon sound anatomical and surgical principles: i.e. the operation is physiologically rational and proceeds in a definite manner to correct a definite etiological defect. In effect the time of operation is shortened, handling of the parts is reduced to a minimum, excess catgut is avoided and the procedure redispenses all of the involved structures into the best (i.e., their original) muscle and fascial planes. Finally, the relative simplicity of its technique renders the operation capable of wide applicability.

### BIBLIOGRAPHY

1. ANDREWS, E. W. Imbrication or lap joint method of plastic operation for hernia. Chicago M. Rec. 1892, lx 67, 7.
2. CAVELL, LEELEST. Recent advances in surgery of hernia. Lancet 4, 4, 8, 483.
3. ERDMANN, S. Inguinal hernia in the male. Ann. Surg. 1923, lxxvii 1, 180.
4. FERGUSON, A. H. Modern operation for hernia. Cleveland Press, 1907.
5. HALSTED, W. L. The radical cure of inguinal hernia in the male. Johns Hopkins Hosp. Bull. 1803, lx 17, 4.
6. HALSTED, W. L. The cure of the more difficult as well as the simpler inguinal ruptures. Johns Hopkins Hosp. Bull. 1903, xlv, 08, 214.
7. MCGREGOR, W. W. The demonstration of a true inguinal sphincter and its rôle in hernia. Sur. Gynec. & Obst. 19, 9, xlix 510.
8. OUDARD, and JEAN, G. Hernies inguinales recidivées. Rev. de chir. Par. 1912, lx 143, 180.
9. SCOTT, A. C. The radical cure of inguinal hernia. Texas State J. Med. 1919-20, xv 56.
10. WATSON, L. F. Hernia. St. Louis, C. V. Mosby Company, 1924.

TABLE II — THE USE AND VALUE OF INDWELLING URETERAL CATHETER DURING OPERATION

- 1 To verify a diagnosis
- 2 As the best guide to identify the ureter and its anomalies
- 3 To prevent migration of ureteral calculi
- 4 To empty a big hydronephrotic sac which facilitates nephrectomy
- 5 In pyelotomy and pyelonephrotomy
- 6 In infected stump ureter
- 7 In ureteral fistula
- 8 In any operation upon the ureter
  - 1 Ureterotomy
  - 2 Ureterectomy
  - 3 Ureteral anastomosis
  - 4 Ureteroneocystostomy
  - 5 Ureterostomy
- 9 For the purpose of kidney pelvis irrigation and the maintenance of drainage
- 10 In certain gynecological operations to avoid injury of the ureter

TABLE III — THE USE AND VALUE OF INDWELLING URETERAL CATHETER AFTER OPERATION

- 1 To obviate renal or ureteral fistula in certain cases of pyelotomy nephrotomy and ureterotomy for calculi
- 2 With the purpose of kidney pelvis lavage and maintenance of drainage
- 3 To secure healing of wound primarily without leakage of urine
- 4 For persistent renal bleeding
- 5 In the occurrence of anuria or uremia combined with daily infusion

fusion of saline solution, and no doubt, many patients have been saved from fatal uræmia by this simple procedure

Therefore it is my purpose, after a review of the literature and our own personal experiences in routine work carried out in the Urological Department of the New York Hospital, to present a resumé of this subject. We see in our daily practice that all patients who come for examination, either surgical or medical, justify the classification of the three groups already described.

The catheter which should be used for the purpose of diagnosis is a No. 6 French  $\lambda$  ray catheter, because of the shadow cast by the roentgen rays and the better contrast in the pyelo ureterogram.

In routine treatment when the catheter is going to be left in place, any catheter will serve the purpose but when possible a larger size, No. 7 or No. 8 would be better for maintaining perfect drainage. Two or three catheters in one ureter have definite value. Papin, Volker, and Bumpus have shown the benefit

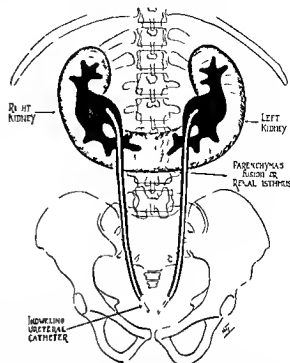


Fig. 3 Drawing of Case 1 showing the horseshoe kidney with its typical characteristics of kidney pelvis calyces pointing inward also showing the indwelling ureteral catheter fixed in position for the purpose of kidney pelvis lavage and permanent drainage

in abdominal pain, or renal colic, when it is caused by stone in the ureter, because the catheter will serve to push the stone back into the kidney pelvis thereby securing a normal drainage and the cessation of pain, allowing at the same time a dilatation of the lumen of the ureter which will aid later in the passage of the urinary calculi into the bladder. Sometimes when the stone is in the intramural ureter, the torsion of the catheters will serve as a net and in pulling out the catheters the stone may also come out. Then the patient may void the stone at urination, but if not it may be easily removed from the bladder by cystoscopic manipulations.

The surprising benefit resulting from the use of an indwelling ureteral catheter in ureteral lithiasis is one of the outstanding achievements of modern urological surgery. Besides making passage of ureteral stones it usually drains the kidney relieving it from back pressure and infection.



Figs. 1 and 2. Case 1. Right and left pyelogram of infected horseshoe kidney treated successfully with indwelling ureteral catheter.

serves, when combined with roentgenography, to detect the presence of urinary calculi or shadows within or without the urinary tract and to disclose certain anomalies and pathological conditions of the upper urinary system that are more clearly revealed in a pyelogram obtained after the injection of an opaque medium into the kidney pelvis.

This technical routine procedure in urological work is well known and perfectly standardized and is described in many publications so there is no need to emphasize it at this time. I wish to report only a few illustrative cases to show the value of the ureteral catheter for correct diagnosis and its striking results in therapeutic treatment (Table II).

During operation, the indwelling ureteral catheter has a definite place. Albarran, in describing its use in certain operations upon the ureter and kidney pelvis, calls attention to the facility and safety of the surgical procedure, both to the surgeon and to the patient. It affords identification readily with exposure of the catheterized ureter, eliminates errors

and fears of cutting, clamping, or tying a normal ureter, and makes the surgeon more sure and confident particularly in the very hazardous and difficult cases or even in the rather common anomalous kidneys and ureters encountered at operation. This pre-operative cystoscopic procedure of catheterizing the ureter which should not take more than two or three minutes to accomplish, is the best help and guide in kidney surgery, its merits deserve a wide general application in safe urological surgery (Table III).

During the postoperative care of surgical diseases of the kidneys the use of the indwelling ureteral catheter should be a part of the treatment, mainly to prevent fistula or urinary stasis that may lead to infection or to delay the healing of the wound. It also secures perfect drainage by kidney pelvic lavage for the purpose of clearing up infection. Many authors have reported striking results in treating "renal colic" or calculous anuria with a fixed ureteral catheter combined with the use of forced fluids and intravenous in-

they have grown too large to pass through even with the aid of the indwelling ureteral catheter or by cystoscopic manipulations.

The etiological study of the formation of urinary calculi is as ancient as the history of medicine and still remains much in the dark notwithstanding the many theories advanced, plus the vast experimental work that has been done recently on animals. But with the new methods of diagnosis at our disposal in modern urology we have come to the conclusion that in the great majority of cases infection plus lack of normal drainage due to pathological conditions of the excretory upper urinary system, has been the chief etiological factor not only of urinary stasis but in many instances of formation of a nucleus for veritable urinary calculi. As a rule outside of the silent stone in the kidney parenchyma infection is always present and plays a definite role. Therefore the securing of drainage will remain as the paramount and most essential of all treatments, as it is to a sound prognosis.

Many of the so called cases of pyelitis and pyelonephritis, with obscure abdominal symptoms and gastro intestinal disturbances characterized perhaps by only microscopic hematuria or a few pus cells in the urine, have proved to be the result of infection in the kidney pelvis, due mainly to retention of urine or faulty elimination, and it has been our experience to see a great number of these cases in our clinic in which the infection, diminution in function, and the positive culture for many micro-organisms have cleared up by means of routine treatment of dilatation of the ureters and kidney pelvic lavage, or the so called indwelling or fixed ureteral catheter, which serves to obtain perfect drainage.

Indeed, the future in urological surgery rests definitely on the correction of infection and the maintenance of function.

In this last decade the continued progress in modern urological diagnosis has secured a new method of examination, which has made it possible to predict the prognosis in certain cases when controlled by pyeloscopic studies. The Necker school has emphasized its value in detecting through the fluoroscopic screen, the physiological contractions and movements in the filling and emptying of the kidney pelvis,



Fig 6. This picture shows the combined use of roentgenography, opaque V-ray ureteral catheter and pyelography in relation to diagnosis of anomalies in the upper urinary tract. It illustrates beautifully a fused kidney which lies in the right side of the lower abdomen and which without this method of examination could easily be confused with an abdominal tumor.

obtaining thus a vivid view of the elimination time of the urine from the kidney, as it has been for years known in regard to the fluoroscopic study of the gastro intestinal tract.

The normal kidney pelvis injected through the catheterized ureter with the opaque medium of sodium iodide, empties its contents, physiologically speaking in from 5 to 7 minutes, and whenever its contraction in emptying is slow or retarded, urinary stagnation with tendency to develop infection, or hydro-nephrosis or pyohydronephrosis is consequently in many instances, a common occurrence. Lack of normal drainage or retention in the kidney pelvis may be detected by pyeloscopy, this condition can also be detected by taking a third or fourth plate or roentgenograms in series 10 minutes after the pyelogram and ureterogram are made. This method will serve to reveal much unknown and overlooked kidney pathology and will demonstrate at the same time that the placing



Fig 4 X ray picture showing the value of the indwelling ureteral catheter as a means of diagnosis demonstrating that the two shadows in the ureter correspond with the shadow of the catheter

The catheter should be left in place for one hour or one day, indefinitely but the average time is from 3 to 7 days if required. It is essential that irrigation be done at least three times daily with a mild antiseptic solution in order to prevent the blockage of the catheter with blood or pus to reduce the kidney infection and to maintain a perfect drainage.

Albarran devised a special kind of ureteral catheter, tunnel type in form with an open end to be used as an indwelling catheter, so that later, when it becomes soft and does not serve the purpose of securing drainage, a long thin catheter attached to a bougie (as an urethral filiform is attached to the tip of a sound) could be passed through it and left in its place removing the first one without submitting the patient to further cystoscopy. But, in these days, it is not commonly used due perhaps to the diversified improved cystoscopes which facilitate painless procedure.

The contra indications to an indwelling ureteral catheter are the same as those to cystoscopy. The urethra must be permeable and without actual acute or chronic infection or ventable discharge. The catheter should be removed or replaced in certain instances when



Fig 5 X ray picture of the same case showing beneficial results of the indwelling ureteral catheter which served to dilate the ureter and facilitated the passage of the stone

necessary but it should be definitely taken out when it causes discomfort or pain to the patient and in cases of chill or high temperature.

It is well to remark that there is no definite rule governing the principle of the indwelling ureteral catheter because each case is a law unto itself and clinically or surgically should be treated according to its own requirements. Not long since ureterotomy for stone was a common operation in urinary surgery, but in these days it has become rather rare in view of the fact that 90 per cent of all small and medium sized stones of the ureter and kidney pelvis diagnosed are passed by means of an indwelling ureteral catheter or by dilatation with bougies of ureteral cystoscopic manipulations.

It is wise at this time to emphasize the principles relating to the formation and reformation of stone in the urinary tract because the latter believed for a time that urinary calculi are dissolved by internal medication and passed out. This theory should be no means be considered because stones in the urinary tract whenever found, are eliminated only by spontaneous passage at micturition when they do not encounter any mechanical obstruction, or by removal at operation when



Fig. 8 This case illustrates the value of the ureterogram for detecting pathological anomalies of the ureter. With the patient in the erect posture the catheter is withdrawn and at the same time the sodium iodide is injected. This case shows a double kidney pelvis and a double ureter with the ureters united before reaching the bladder and therefore showing cystoscopically a normal bladder with normal ureteral orifices. This condition could not be detected without this routine examination.



Fig. 9 Case 2. Pyelo ureterogram showing a rectangular calculus blocking the injection of the opaque medium at the ureteral pelvic junction. On the left side three distinct extra urinary shadows due to calcified lymph nodes.

obtaining satisfactory results in the treatment of such cases when there is an infection and lack of proper drainage.

**CASE 2.** Use of the indwelling ureteral catheter during nephrectomy for calculous pyohydronephrosis.

Miss L. D., 18 years old, born in Scotland, came to the female clinic of the Urological Department of the New York Hospital on December 24, 1918, complaining of pain in the right kidney region of over 1 year's duration. She suffered from frequency of urination and nocturia four to five times and pyuria and dysuria. Her previous history was irrelevant. Menstruation started at the age of 12 and was always regular. The symptoms and urinary complaint were getting worse and produced fatigue and constant pain in the right lumbar region radiating along the ureter down to the right quadrant. The patient was cystoscoped and the bladder mucosa throughout was found to be slightly congested but otherwise of

normal appearance. On catheterization of the ureters specimens were collected from the left side and none was obtained from the right. The functional tests showed that the left kidney was within normal limits. There was secreted urea 15 grams per liter and the time of appearance of the dye after the phenolsulphonaphthalein injection was 3 minutes with 10 per cent concentration. The culture was negative but the culture of the urine from the bladder showed *bacillus coli communis*. The patient returned a week later when another cystoscopy was performed and a specimen was sent to the laboratory for a guinea pig inoculation. Also plain pictures and a right pyelogram were taken revealing a rectangular shadow, apparently in the pelvis of the right kidney at the point of the ureteropelvic junction, therefore blocking the normal drainage of the organ. The left kidney shadow was normal in size and in good position and there could be seen three small round shadows apparently in the contour of the left kidney but extra urinary and therefore probably calcified lymph nodes. The right pyelogram showed almost a complete blockage of the right pelvis by the stone so that none of the sodium iodide entered the pelvis but ran down the right ureter which is apparently within normal limits. The impression gained was that of a rectangular stone in the right kidney pelvis and it was suggested that the stone be removed under regional anesthesia. The patient entered





Fig 7 Bilateral double kidney and double ureter diagnosed cystoscopically roentgenographically and pyelographically showing kink in the ureter and urinary stasis plus infection which was successfully treated with indwelling ureteral catheter (Kierwin's case)

of the fixed catheter is of great practical value, because it serves to secure drainage from the kidney pelvis of the retained sodium iodide and will prevent the reactions after pyelography such as kidney pain and more or less discomfort until the medium is absorbed or eliminated.

The indwelling catheter after pyelography is therefore highly desirable because it will serve to permit the suction of the opaque medium also lavage of the kidney pelvis thereby relieving pain and maintaining perfect drainage.

I shall describe a few cases which I have had the good fortune to encounter in my own practice and which will serve to illustrate the routine procedure used in the three groups described in the three accompanying tables wherein is briefly explained the incidence of the value and use of the indwelling ureteral catheter.

**CASE 1** Value of indwelling ureteral catheter in the diagnosis and treatment of infected horseshoe kidney.

D. S. male 18 years old poorly nourished appeared acutely ill very pale feeble with a blood

pressure of 108-60. He had been sick in bed for the last 2 months before he was brought into The New York Hospital. He consulted me on October 15, 1928 complaining of pain across the lower back with dysuria marked pyuria nausea vomiting head ache and high temperature. The family history and the past personal history are irrelevant except that he had an attack of malaria 9 years previously and had been suffering with chronic constipation all his life also for many years he had pain in the back particularly radiating to both lumbar regions. Slight frequency of urination both during the day and at night had persisted for many years and was more troublesome whenever he caught cold. On arrival at the hospital cystoscopy was done with a functional renal test and a pyelogram of the right side revealing the presence of a horseshoe kidney with pyelitis and pyelonephritic infection. The ureteral catheters were inserted into the kidney pelvis in order to secure drainage and for the purpose of irrigation. The patient was put on forced fluids having as medication methylene blue and quinine sulphate three times daily internally. Also 1000 cubic centimeters of saline intravenous infusion was administered daily and high colonic irrigation was also instituted. The patient's temperature ran from 101 to 103 degrees for 7 days although his general condition was much improved and he was able to take food and to eliminate large quantities of urine. His blood chemistry was higher than normal and the Wassermann test was negative. On the eighth day another cystoscopy was performed when a pyelogram of the left side was made showing the calyces of the kidney pelvis also pointing inwardly and therefore proving the presence of a fused horseshoe kidney. A slight degree of hydronephrosis with lack of drainage and infection was also detected. The catheters were reinserted and left fixed in place. The sodium iodide was suctioned and the kidney pelvis irrigated with plain distilled water. This was followed with an irrigation of the kidney pelvis with a solution of acriflavine 1 to 1000. The patient gradually improved the temperature came down to normal and he left the hospital on November 1, 1928 with the diagnosis of infected horseshoe kidney to which he was advised to return for further treatment consisting of dilatation of the ureters and kidney pelvic lavage. This treatment has been carried out at intervals of 2 weeks on several occasions and this patient at the present time is free from symptoms and his urine is clear. He is generally improved has gained in weight and has resumed his occupation. However the patient has been advised that if this pathological condition of the kidney persists in troubling him it will be necessary to consider a symphysiotomy operation in order to separate the fusion of the kidney parenchyma from its isthmus.

This case shows the value of an indwelling ureteral catheter both in regard to diagnosis when combined with pyelography and in



Fig 11 Case 3. Bilateral renal lithiasis showing the opaque ureteral catheter in contact with the renal calculi

examination was again made. The specimen obtained from right ureter was clear and showed 10 grams of urea per liter while specimen obtained from the left side was cloudy and showed 4.5 grams of urea per liter. One cubic centimeter of phenol sulphophthalein injected intravenously appeared on right side in 4 minutes and on left side in 4.5 minutes. The phenol sulphophthalein test showed secretion on the right side 8 per cent in 10 minutes and 2 per cent on the left side. Microscopical examination of the urine from the left kidney showed it to be loaded with pus cells. However her general condition was much improved the patient had gained 22 pounds in weight and as her kidney function and blood chemistry were better it was suggested that the stone that occupied the complete left pelvis be removed by *nephrotomy*.

The patient was re-admitted to the hospital on March 18, 1929 and under paravertebral anesthesia *nephrotomy* was performed and the large stone from the left kidney was removed successfully. During the operation the kidney was found to be quite large it contained pus but the parenchyma still appeared to be in good condition and therefore sufficient to maintain satisfactory function. The patient had an uneventful recovery and left the hospital 16 days after operation with a small lumbar sinus but in very good condition.

It is of interest to remark in this case how, by simple cystoscopic treatments with cath-

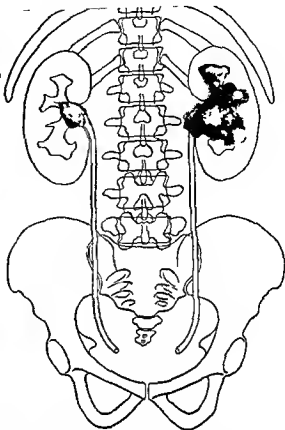


Fig 12 Case 3. Actual size of the two kidney stones removed at operation

terization of the ureters and kidney pelvic lavage, and the method of the indwelling catheter, this patient steadily improved, and notwithstanding the urinary complaints and infection caused by the stones in the kidney pelvis her general health improved with this treatment and thus we could perform successfully the two operations for the removal of the offending stones. The first operation was done by me March 23, 1928, and the second one was done by Dr. Lowsley, one year later in March 1929. The two operations *pyelotomy* and *nephrotomy* were carried out in order to remove the bilateral kidney stone, paravertebral anesthesia being used under which the patient did exceedingly well. She made a complete recovery.

CASE 4. Value of fixed ureteral catheter after *nephrectomy* for renal tuberculosis in an attempt to aid the healing of the lumbar wound.

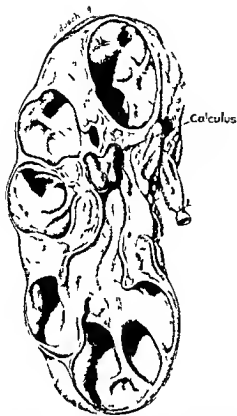


Fig 10 Case 2 Drawing of specimen removed at operation showing the rectangular calculus which had blocked the normal drainage of the kidney and produced the distortion of the whole organ ending in the formation of pyohydronephrosis

the hospital on February 17 1929. In this case the patient was cystoscoped before the operation the right ureter being catheterized with a No. 6 French catheter which was left fixed *in situ* during the operation with the purpose of facilitating the surgical procedure and readily exposing the ureter. At the operation when the kidney was exposed it was found to be a shell or a definite pyohydronephrosis with complete distortion of the whole kidney parenchyma and was functionless. Therefore nephrectomy was performed. After a most satisfactory surgical exposure the catheter was pulled out by an assistant and then the ureter was clamped cut and tied in the usual manner. The kidney was removed the pedicle was tied and the wound was closed with small cigarette drainage. Patient made an uneventful recovery and returned home in weeks with the nephrectomized wound closed and practically free from urinary symptoms.

CASE 3 Bilateral renal lithiasis. Right pyelotomy, and one year later nephrotomy for removal of the calculi. Uneventful recovery. The value of the

indwelling catheters in this case is correcting infection and securing drainage.

S. A. an Italian woman 50 years of age came into the female clinic of the Department of Urology of the New York Hospital March 23 1928 complaining of pain in the right upper quadrant for the past 2½ years with slight frequency of urination and marked nocturia. Urinalysis showed considerable pus. The patient was submitted to complete urological examination. On cystoscopy examination the bladder was found to be very much congested throughout both ureters were catheterized and the functional test was quite diminished on both sides. An X-ray picture was taken with the catheters and the instrument fixed in position and showed two enormous shadows in the area of both kidney regions. Therefore a diagnosis of bilateral nephrolithiasis was made. The right kidney having much better function than the left the patient was admitted to the hospital and pyelotomy for removal of the stone on the right side was done. The patient had an uneventful convalescence and the lumbar wound was firmly healed. But on the seventh day of the operation she developed pain on the side of the operation and it was easy to palpate a fairly big distended right kidney. She was running a temperature from normal up to 102 degrees. The patient was then cystoscoped and on catheterization of the right ureter a considerable amount of thick green pus was obtained. The catheter was left in place and the kidney pelvis was irrigated with acriflavine 1:1000 several times. The catheter was removed in 48 hours and the patient was submitted to another cystoscopy 3 days later when much purulent urine was still suctioned from the kidney pelvis. The catheter was left in place for several hours in order to secure drainage and to irrigate the kidney pelvis. The patient's temperature came down to normal and she left the hospital on April 23 1928 when I advised her to return to the clinic where she received weekly cystoscopic treatments with kidney pelvic lavage for several months. The infection subsided and she was sent to the country in order to build up resistance for the second operation. Six months later upon her return her general condition was greatly improved but she was still suffering with a dull pain in both kidney regions and frequency of urination. Cystoscopy and renal tests were made again showing that functional tests in regard to urea secretion and time of appearance of the phenol sulphonephthalein were very much improved. A summary of the past history of the case is of interest and shows that on October 31 1928 the phenol sulphonephthalein test showed secretion 0.05 per cent in 10 minutes on the right side and 3 per cent on the left side. Cultures from right and left ureters showed bacillus coli communis. An X-ray of the genito-urinary tract taken on February 15 1929 showed the left kidney shadow to be large in size and in fair position and the entire pelvis was filled with calculi. On March 6 1929 the kidney function was still markedly diminished. A cystoscopic



Fig 15 Case 5 Plain X ray plate showing the value of the ureteral catheter in diagnosis when the shadow of the stone in the ureter corresponds with the shadow of the catheter

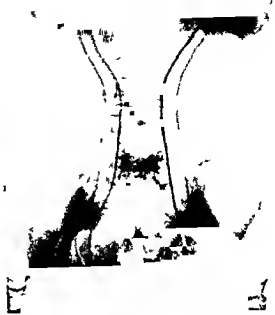


Fig 16 Case 5 Picture shows the Kretschmer double exposure to determine that the shadow of the urinary calculus corresponds with the shadow of the catheter

P T an Italian woman aged 55 years married was admitted to the medical ward of the New York Hospital on June 13 1928. The diagnosis was acute pyelitis nephrolithiasis and diabetes mellitus. The patient was submitted to numerous cystoscopic examinations that apparently relieved her condition and she was readmitted to the medical ward a few days later complaining of pain in the right lower quadrant accompanied with chills and bladder symptoms with marked pyuria and frequency of urination. The interesting feature in this case is that while she had the first cystoscopic examination and pyelogram made the diagnosis of stone at the ureteropelvic junction was made and this patient was submitted to further cystoscopic treatments for dilatations of the ureter and kidney pelvis lavage for the purpose of allowing the passage of the stone and to correct infection. In subsequent examinations the shadow of the stone in the X ray plates was found to be at the ureteropelvic junction apparently impacted in that portion of the ureter and being the cause of the retention which produced the presence of acute infection in the right kidney. A plain X ray picture with the catheter in position and with the Kretschmer double exposure showed a definite shadow of urinary calculi in the upper portion of the right ureter just above the transverse process of the

third lumbar vertebra. This point was beautifully corroborated by the filling defect at that point in the pyelogram. As the patient was submitted to numerous cystoscopic treatments and kidney pelvic lavage in the genito-urinary clinic of the New York Hospital and did not pass the stone but developed high fever tender kidney and acute renal condition operation for the removal of the stone was advised. The patient entered the hospital and ureterotomy for the removal of an impacted stone of the right ureter was performed on December 14 1928 under paravertebral anesthesia. Before the operation the patient was put in the lithotomy position on the table and cystoscoped without difficulty. A large No 7 ureteral catheter was passed up to the pelvis of the right kidney and allowed to remain. The cystoscope was then withdrawn and the patient was put on the table in the usual position for a kidney operation. It was striking to find during the operation that the catheterized ureter was readily exposed and that there was not any urinary calculus found in this catheterized ureter. Then search for an extra anomalous ureter was made and a super numerary ureter containing an impacted stone was found. This anomalous ureter ran from the upper portion of the pelvis of the kidney down about one half the way to the bladder uniting with the ureter



Fig. 13 Case 4 Right pyelogram of a tuberculous kidney showing a completely distorted and functionless organ

**S L History** No 157480 an Italian woman 35 years of age, married, came to the female clinic of the urological department of the New York Hospital on August 2, 1928, complaining of pain in the right lumbar region, intermittent hematuria for 1½ years. She suffered from marked pyuria with pain and burning at urination, also frequency during the day and at night as often as every half hour during the day and several times at night. Patient was submitted to complete urological examination. On cystoscopy a definite ulcer involving the mouth of the right ureteral orifice was detected. As the patient had a very poor bladder capacity and complained of pain, catheterization of the ureters was not made. She was submitted to bladder lavage and methylene blue was given. Two weeks later another cystoscopy was done with catheterization of both ureters. This examination showed that the left kidney had good function and that from the right side no specimen of urine could be obtained. Even after injecting a few cubic centimeters of water no dye was eliminated. Pyelogram of the right side was taken showing a greatly excavated kidney giving the impression of a tuberculous pyonephrosis. The patient was submitted to the hospital for operation September 13, 1928 and a right nephrectomy was performed under paravertebral anesthesia. The patient left the hospital October 22, 1928 with a small lumbar sinus which discharged purulent urine for which she was treated, in the anti-tuberculous clinic with anti-



Fig. 14 Case 4 Pyelogram taken of the kidney specimen removed at operation showing complete distortion of the organ with very little parenchyma remaining, verifying the diagnosis of kidney tuberculosis

tuberculin and light treatment. She also had a few cystoscopic treatments with irrigations of the stump ureter with a solution of rivanol dextrose 1:1000 and on several occasions the ureteral catheter was left fixed in place to secure drainage and to allow the lumbar wound to heal. Also the ulcer at the mouth of the ureteral orifice was fulgurated with an electrode on two different occasions. The patient's wound healed up entirely, as well as the tuberculous ulcer of the bladder and she made a complete recovery. Six months after the operation the patient had gained over 60 pounds in weight and her general condition was excellent and she was entirely free from urinary symptoms.

In this case the fixed catheter aided in the healing of the wound, securing drainage, relieving infection and hastening the complete closure of the wound thus effecting a permanent cure.

**CASE 5** Ureterotomy for impacted stone in an anomalous ureter. Value of the indwelling ureteral catheter during operation to corroborate diagnosis, to discover anomalies encountered at operation and to facilitate safe surgical procedure. Case of double ureter containing stone where urography did not reveal the condition found at operation.

results, for instance Watson and Cunningham, in an analysis of 205 cases of calculous anuria, in which a group of 110 such cases were treated expectantly, reported deaths in 80 cases, a mortality of 72.7 per cent, and in an other group of 95 cases, treated operatively, reported deaths in only 44 cases, a mortality rate of 46.3 per cent. Therefore, while many of these cases could have been treated satisfactorily with the method of the indwelling catheter as recently emphasized by Marion and Heitz Boyer, Papin, Beer, Lisendrath, and other writers, at the same time one should not wait too long because if relief from symptoms is not obtained in a reasonable length of time, surgical intervention is the operation of choice. In other words, the indwelling ureteral catheter is not a panacea for all pathological conditions of the upper urinary tract. Nor should operative intervention, when required, be delayed. Moreover, it is obvious that the diagnosis must be accurate and definitely clear, because besides a few contra indications this method should not be used in cases of extrarenal or intrarenal conditions of the kidney when the pathological process has become well advanced or does not communicate with the excretory apparatus of the organ, as in the case of perinephritic abscess, cortical abscess of the kidney, or well advanced renal tuberculosis or hypernephroma of the kidney, when surgical relief must remain as the most imperative hope of cure.

#### CONCLUSIONS

1 The indwelling ureteral catheter is of value in urinary surgery, not only in regard to diagnosis and treatment but as a convenience during and after operation.

2 The empiric classification of the three groups in the three accompanying tables is made only for the purpose of popularizing a practical procedure, which deserves a wide application.

3 The catheter to be used is preferably a No. 6, No. 7, or No. 8. It should be an X-ray catheter because this type is more durable, more flexible and produces less discomfort.

4 It is essential that the catheter must serve its purpose, that is secure drainage, relieve pain and correct infection.

5 The fixed catheter should be irrigated at least three times daily, with a mild antiseptic solution as boric acid or acriflavine 1:10,000. Also, in certain cases, when possible, two catheters in the same ureter and continuous irrigation may be definitely indicated.

6 The catheter should be left fixed in place for a period of days or even weeks, until symptoms are relieved or as long as necessary.

7 In leaving the indwelling ureteral catheter *in situ*, in certain cases in which there is marked infection of the bladder or in which the bladder does not empty properly, it will be advisable to use a retentive urethral rubber catheter with the double purpose of securing drainage of the infected urine, indefinitely, both from the kidney pelvis and from the bladder. When this double drainage is required, the urethral catheter should be easily passed, it being inserted through the indwelling ureteral catheter.

8 During operation, the fixed ureteral catheter is the best guide to the surgeon. It affords ready exposure of the ureter and facilitates any surgical procedure upon the kidney pedicle.

9 The most striking results are obtained with this method of treatment in "renal colic," ureteral calculi, pyelitis and pyelonephritis, the so called idiopathic hæmaturia, urinary stasis with or without infection, and in calculous anuria. Also in certain instances when elimination of urine is insufficient, forced fluid and daily intravenous infusion are highly desirable.

10 After operation, it will serve to secure drainage and prompt healing of the wound, without leakage of urine or the formation of permanent fistula.

11 Also, after operation, it will serve, too, to divert the urine from the bladder, particularly in operations on vesicovaginal fistulae, thus permitting the bladder to heal without infection from the urine.

12 The technique of the indwelling ureteral catheter is merely that of cystoscopy and catheterization of the ureters and to accomplish it, it does not require more than a working knowledge of these methods by the urologist.



Fig. 17 Case 5. Pyelogram showing a filling defect at the ureteropelvic junction or upper portion of the ureter where the shadow of the calculus was seen in the plain picture. In this case the ureterogram was not taken, thus failing to reveal the anomaly of an extra ureter containing the calculus which was discovered at operation while having the ureteral catheter fixed in place.

which was previously catheterized about the middle of the iliac vessels. The indwelling ureteral catheter during operation proved to be of great assistance in detecting this anomalous condition of the ureter, not revealed by the pyelo ureterogram, and it facilitates the surgical procedure in a most satisfactory manner.

The ureter was incised and the stone was removed in the usual manner, the lumbar wound being closed in layers. The patient had an uneventful recovery. The wound healed by primary intention and the patient left the hospital in 14 days in excellent condition.

#### SUMMARY

The indwelling ureteral catheter is the most valuable adjunct in urological surgery. Its clinical results obtained in selected cases are most gratifying, but always of paramount importance is correct diagnosis before establishing the proper treatment, because it is obvious that no treatment will ever be adequate if the clinical entity has not been recognized.

In acute clinical conditions, likewise in calculus anuria, if the indwelling ureteral catheter



Fig. 18. Technique of operation in Case 5 showing the value of the indwelling ureteral catheter during operation. The catheterized ureter is readily identified but no stone was found in the ureter and on further dissection an extra ureter was discovered containing the impacted stone which was successfully removed by ureterotomy. The two test ureters united before they reached the bladder and urography did not reveal the condition. This pre-operative procedure of fixing the ureteral catheter *in situ* has proved to be most helpful and satisfactory.

ter fails to relieve the alarming symptoms, surgical intervention should not be delayed (Case 5). The life of our patients could be saved by any operative procedure upon the kidney or ureter in an attempt to remove the obstructing calculus and to secure urinary drainage.

One of the most common incidents in the pathology of nephrolithiasis or ureterolithiasis is the calculus anuria or suppression of urine toward the formation of uronephrosis and fatal uraemia, and the statistics have shown evidence of the gravity of this condition. It has been proved also by many authors that the early operative intervention gives better

# CLINICAL SURGERY

FROM THE SURGICAL CLINIC OF ST VINCENT'S HOSPITAL, MELBOURNE

## ABDOMINAL TECHNIQUE—A SYSTEM OF OPERATIVE EXPOSURES

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ADEQUATE exposure is the great secret of success in the performance of abdominal operations. It should be such that the surgeon is able to dissect or carry out any manipulations in the particular operation field under perfect sight that he is undisturbed and unhampered by the neighboring viscera, and that the organ or organs on which he is operating are, as far as possible, under normal physiological conditions.

It is, of course, a common and traditional practice during the progress of an operation on an organ, to drag it out of the abdominal cavity; such a procedure does not constitute a truly scientific exposure. The proper way is to isolate, expose, and operate on the organ while it is *in situ*, that is, while it is in the abdominal cavity where it is naturally kept warm and moist. In these circumstances there is no necessity to handle bowel or to drag on mesenteries, both of which are richly supplied with shock-susceptible splanchnic nerves. It is perhaps not sufficiently realized what a big factor unnecessary interference with physiological conditions during an operation is in producing shock and inducing inhibition of the movements of the alimentary canal. This has often been signally apparent to us when operating on the abdomen under local anaesthesia. It has been remarkable to see the distinct change in the patient's general condition if much visceral dragging or handling becomes necessary, although no pain is produced. On the other hand, while manipulations on a poorly anaesthetized abdominal wall give rise to pain they have almost a good effect on the patient's general condition.

Many years ago, having these basic considerations in mind, we evolved a system of abdominal technique, the exordium of which was woven round a rather crude mechanical retractor, designed so that these and other desired principles in abdominal technique might be carried out. It was originally an expedient to render possible certain extremely difficult practically impossible,

secondary gastric and gall bladder operations. This clean, definite, standardized method of operating gradually forced itself by its very potentiality and usefulness into our technique in other abdominal fields. We soon found that it made abdominal operating easier and quicker, so that if it did nothing else it minimized anaesthesia and lessened shock to the patient. Also it saved strain and conserved the energy of the operator.

The keystone of the technique is a gentle, evenly distributed, unvarying protecting instrumental retraction and control of the abdominal wound and wall. Principles concerned in this technique and attained by and embodied in the use of this retractor are:

- 1 Effective wound protection from trauma and infection.
- 2 Control of the anterior abdominal wall, so that it can be lifted away from the viscera, thus creating a space for (a) operative manipulation, (b) exploration, (c) the easy replacement of intestines, and (d) the toilet of the peritoneum of the anterior abdominal wall.
- 3 Isolation of the organ to be operated on by complete instrumental exclusion of the intestines from the area of operation.
- 4 Systematic 'guy rope' anchoring of hollow viscera to the frame, enabling gastric or intestinal suturing to be carried out against constant tension with great precision, exactitude, and neatness.

5 A ratchet "spreader" action enabling the retractor to be used for the surgical approach to the kidney, lung, bladder, etc.

We soon found that an extraordinarily light anaesthesia was possible because the anterior abdominal parietes were not constantly being handled, and because once the retractor and its 'mechanical hands' were "set," great relaxation was not a consideration.

Difficulties in suturing the abdominal wound also disappeared probably because the light but



## BIBLIOGRAPHY

- 1 ALBARRAN J. Maladies chirurgicales du rein et de l'urètre. Traité de chirurgie by Le Dentu and Delbet Vol viii pp 595-600 Paris 1899
- 2 Idem. De la sonde urétérale à demeure après la nephrotomie. Rev de gynéc et de chir abd 1900 January
- 3 Idem. La sonde urétérale à demeure dans le traitement préventif et curatif des fistules rénales consécutives à la nephrotomie. Rev de gynéc et de chir abd 1901 v 43-99
- 4 Idem. Cathétérisme des ureteres in Guyon's Leçons Cliniques sur les Maladies des Voies Urinaires iii Leçon 35 p 280 Paris 1903
- 5 Idem. Exploration des fontions rénales Paris Masson et Cie 1903 p 294
- 6 Idem. Médecine opératoire des voies urinaires Paris Masson et Cie 1909 pp 377-381
- 7 BEER and HAIN. Use of indwelling catheter to induce passage of ureteral stones. J Am M Ass 1925 lxxvii 1028-1029
- 8 BRAASCH and SCHOLL. Pathological complications with duplication of the renal pelvis and ureter. Surg Gynec & Obst 1922 xxvii 401-417
- 9 BUMPES H C. The treatment of pyelonephritis etc. J Urol 1923 xi 453-459
- 10 CABOT H. Modern Urology. Vol ii pp 576-634 Philadelphia and New York Lea & Febiger 1924
- 11 CALLK J R. J Am M Ass 1917 lxxvii 675
- 12 EINENDRATH D N. Inlying ureteral catheter in treatment of pyelonephritis and other renal conditions. Tr Am M Ass Sect Urol 1917 pp 228-234
- 13 ELIOT. Anurie au cours de la lithiase et des tumeurs et néoplasmes pelviens. Thesis de doct Paris 1910
- 14 FEY TRICHOIR and DOSSOR. La motricité normale et pathologique du bassin: son exploration par la pyeloscopie. Arch urol de la Clin de Necker Vol v fasc 1
- 15 GOLDBEIN A E. A study of urinary stasis in ureteral obstructions. J Urol 1925 xiv 33-45
- 16 GUTIERREZ R. Non surgical renal tuberculosis. Am J Surg 1918 v 99-113
- 17 HUNTER G L. Calculus of the upper urinary tract treated by new methods and results. J Urol 1928 pp 61-81 July
- 18 JEANBRAL F. Lithiase urétérale. Encyclopédie française d'Urologie Vol iii pp 83-86 Pan Don et Fils 1914
- 19 Idem. Technique des opérations pratiquées sur l'urètre. Encyclopédie Française d'Urologie Vol iii pp 997-1035 Paris Don et Fils 1914
- 20 KELLEY and BLUMHART. Diseases of the kidneys. Ureters and Bladder. Vol ii pp 437-441 New York Appleton 1915
- 21 KEYSER. The mechanism of the formation of urinary calculi. Ann Surg 1913 February
- 22 KIRWIN T J. The rôle of the ureter in diseases of the genito-urinary tract. Am J Surg 1918 pp 323-384 April
- 23 KRETSCHMER H L. A new procedure for the localization of ureteral stone. Surg Gynec & Obst 1918 lxxvii 472-474
- 24 LEGLEU FEY and TRICHOIR. La Pyeloscopie. Paris Maloine 1927 pp 20-22
- 25 LOWSLEY and KIRWIN. A Text Book of Urology. Philadelphia Lea and Febiger 1916 pp 581 and 673
- 26 MACCOW J A H. Temporary ureteral drainage. J Urol 1927 pp 463-464 April
- 27 MARIOT and HEITZ BOYER. Traité pratique de cystoscopie et de cathétérisme urétéral. Paris Masson et Cie 1923 pp 361-389
- 28 PAPIE E. Endoscopie Opératoire des Voies Urinaires. Paris Maloine et Fil 1913 pp 73-107
- 29 PUGH W S. Pyelitis of pregnancy its treatment with large size indwelling catheters. J Urol 1924 pp 553-573
- 30 RATHBUN N P. The incidence of ureteral stricture. J Urol 1913 xiv 403-410
- 31 ROSENOW and MEYER. Nephritis and urinary calculus following the experimental production of chronic foci of infection. J Am M Ass 1912 lxxviii 266
- 32 THOMAS G J. Tr Ass Res and Ex Res Phys Mayo Clinic Vol vi pp 261-66
- 33 THOMSON WALKER J W. Surgical Diseases and Injuries of the Genito Urinary Organs. New York and London Funk & Wagnalls 1914 pp 15-283
- 34 WATSON and CUNNINGHAM. Diseases and Surgery of the Genito-Urinary System. Vol ii pp 108-211 Philadelphia Lea and Febiger 1908

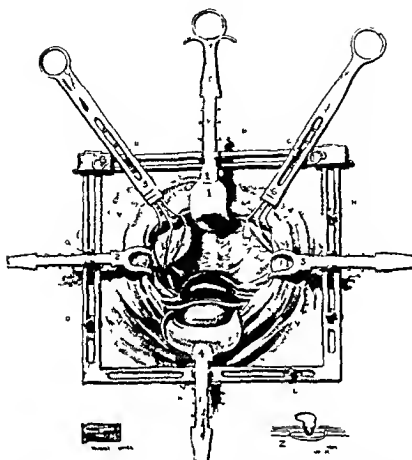


Fig. 2. Retractor set for a pelvic operation. The incision is in the lower part of the abdominal wall. The edges of the wound are covered with rough glove rubber. Mechanical hands 5 and 6 with a soft scarf acting as a buffer keep the intestines well out of the wound and well up into the abdominal cavity. The pelvis is empty except for the rectum, uterus, and its adnexa. 7. Section of a single hook to show how it jams and fixes the mechanical hands.

inches (Fig. 3) are laid over the wound so that they overlap its edges well. The frame is laid on these and if the wound is in the upper part of the abdominal wall (Fig. 3) the left forefinger is placed on the towels at the lower angle of the incision where they are tucked well under the cut edge of the abdominal wall. Retractor 1 is now substituted for the finger and is held up by the left hand of the assistant so as to elevate the abdominal wall until it is clear of the viscera and thus enable the operator with his left hand at C to tuck the towel at this point well under the peritoneum and unhampered by intestines to insert retractor 2 and lock it on the frame. The assistant using his right hand pulls the frame

toward him and keeps it on tension at the point C so that omentum or intestines cannot get under retractor 2. He still retains the upward tension on retractor 1. This facilitates the insertion and the locking of retractor 3. Retractor 1 is now locked. The assistant with his hands at E and G now lifts the frame enabling the towels to be easily turned under the peritoneum in the upper wound angle and permitting the insertion and locking of retractor 4.

The wound now should be open to its fullest extent under slight tension only and the wound edges, including peritoneum, should be neatly covered so that there should be no fear of disarrangement, damage, or infection (Fig. 3).

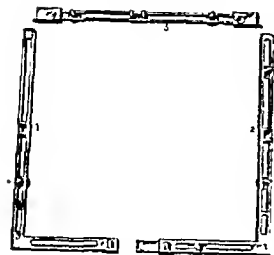


Fig. 1. Four bladed abdominal retractor 1 and two slotted L pieces which dovetail into each other 3 sliding bar which moves on 1 and 2 by ratchet action 1 B and 2 double hooks for retractors 1 C H J A and O single hooks for attaching mechanical hands. All these lock the retractors and mechanical hands by a jamming action on the frame because they work on a series of inclined planes.

continuous pressure of the retractor fatigued the abdominal muscles.

The results, both immediate and remote were exceedingly good for this method of operating demanded and developed a special type of desirable operative skill, that is, accurate detailed dry dissections under good vision with long very sharp instruments—really an ideal technique.

That this meticulous and precise method was justified was demonstrated by observations in any secondary operations after this technique. These revealed a remarkable absence of adhesions and some abdomens looked as if they had never been opened before. Since the adoption of this technique, wound infection has been almost unknown to us. Perhaps the most noticeable thing certainly from the patient's point of view is the placid postoperative course, the absence of any definite "after treatment" period. Indeed, the sisters have often volunteered the information that the patients operated on in this way may be distinguished by the remarkably little after treatment they need. We have often demonstrated that, intelligently used, the retractor never in the least degree traumatizes the wound.

In the light of the foregoing it is difficult for us to understand why some surgeons still have a prejudice against the use of proper instrumental retraction, why they prefer to draw the viscera

out of the abdominal cavity where they are kept warm and moist and why they should really make difficulties as for instance, by operating in an area which is inadequately lighted because their own and their assistant's hands are in the light, and because the crowding in of the intestines and of the wound edges prevents the access of natural light to the part.

#### THE RETRACTOR

The retractor has been redesigned in the light of ten years' experience, and is here illustrated for the first time, Figure 1. It consists of two slotted L pieces 1 and 2 which dovetail into each other a sliding bar, 3 which moves on 1 and 2 by a ratchet action, four retractors (1, 2, 3 and 4 Fig. 2) for clamping the abdominal wound a system of mechanical hands (5, 6, 7, 8, and 9 Figs. 2 and 3 with detachable blades of different shapes and angles Fig. 4).

The instrument is so designed that there are no screws yet the retractors and 'mechanical hands' by a jamming action remain firmly on the frame in whatever position they are placed. This is accomplished by a system of inclined planes incorporated in the frame and in the single hooks (H, A, L, O L) and double hooks (B, O V I) in Figure 2 and in the retractor and handles of the 'mechanical hands'.

When the 'mechanical hands' are inserted it is particularly necessary to note that they are always at first loosely fixed on the single hook at C (Fig. 5) or a point corresponding to it, that is with the handle at right angles and near the center of the bar. A firm lateral movement to  $L_1$  (Fig. 5) will now tighten and jam the 'hand' as the side  $L_1-L_2$  is longer than the side  $C_1-C_2$ .

Except for the frame and 'mechanical hands', the retractors used belong as a rule to the armamentarium of any surgeon.

#### 'SETTING THE OPERATION FIELD'

The field of operation should be set deliberately as a stage of the operation. It is better to make a somewhat smaller incision than usual in order to get the spring like action of the muscle. It is this that really retains the retractor firmly in position and gives the frame its lifting purchase on the abdominal wall. If this lifting purchase is intelligently cultivated and used it becomes extraordinarily useful in abdominal operating.

If there are no adhesions to the abdominal wall as a first step the retractor should be introduced and fixed as follows:

Two very thick towels or two specially made sheets of rough glove rubber 15 inches by 12

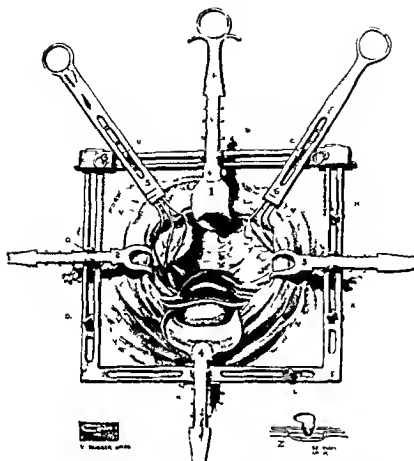


Fig. 2 Retractor set for a pelvic operation. The incision is in the lower part of the abdominal wall. The edges of the wound are covered with rough glove rubber. Mechanical hands 5 and 6 with a soft scarf acting as a buffer keep the intestines well out of the wound and well up into the abdominal cavity. The pelvis is empty except for the rectum, uterus and its adnexa. Section of a single hook to show how it jams and fixes the mechanical hands.

inches (Fig. 2) are laid over the wound so that they overlap its edges well. The frame is laid on these and if the wound is in the upper part of the abdominal wall (Fig. 3) the left forefinger is placed on the towels at the lower angle of the incision where they are tucked well under the cut edge of the abdominal wall. Retractor 1 is now substituted for the finger and is held up by the left hand of the assistant so as to elevate the abdominal wall until it is clear of the viscera and thus enable the operator with his left hand at C to tuck the towel at this point well under the peritoneum and unhampered by intestines to insert retractor 2 and lock it on the frame. The assistant using his right hand pulls the frame

toward him and keeps it on tension at the point C so that omentum or intestines cannot get under retractor. He still retains the upward tension on retractor 1. This facilitates the insertion and the locking of retractor 3. Retractor 1 is now locked. The assistant with his hands at E and G now lifts the frame, enabling the towels to be easily turned under the peritoneum in the upper wound angle and permitting the insertion and locking of retractor 4.

The wound now should be open to its fullest extent under slight tension only and the wound edges including peritoneum should be neatly covered so that there should be no fear of disarrangement, damage or infection (Fig. 3).

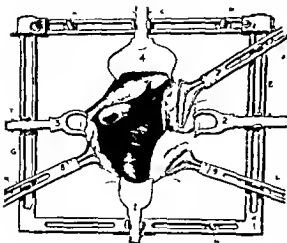


Fig. 3 Retractor set for an operation upon the gall bladder. The incision is in the upper part of the abdominal wall. The No. 1 broad I-ruta retractor is put in the upper angle of the wound. Mechanical hand 9 has the most important function. It draws the duodenum (covered with a scarf) medially and stretches the common duct and draws the gall bladder toward the midline. Mechanical hand 8 keeps the hepatic flexure out of the way and mechanical hand 7 a deep one (cf. Fig. 4) is used to keep the stomach out of the way.

When the incision is in the lower part of the abdominal wall retractor 1 is inserted first in the upper angle of the wound and the others in order of their numbers (Fig. 2).

When there are adhesions to the anterior abdominal wall, as in secondary abdominal operations, a second step will be necessary. Here it is better at the outset to choose or make on each side of the wound a space clear of adhesions. Into these spaces insert retractors 2 and 3 (Fig. 6), lock them on the frame and with this lift the abdominal wall. The viscera will hang and it is an easy matter to put tension on the now well lighted adhesions, thus facilitating what is usually a very difficult task—the neat disconnection of adhesions from the anterior abdominal wall especially those far out from the incision.

When these adhesions have been divided, preferably with a long scissors and the operation field is "set," then the abdominal wall is lifted away from the intestines by the gentle elevation of the frame. In this way a space is created through which the operator can explore the abdomen. As a matter of fact, much of the abdominal cavity can in this way even be inspected under good vision certainly it can be explored comfortably because the exploring hand is not hampered and harassed by the intestines and the clinging omentum. It is also wise at this stage to

see to the suturing of any wound made in the peritoneum of the anterior abdominal wall by the severance of adhesions. Lifting the abdominal wall away from the viscera enables this to be done with ease and accuracy, even though the wounds are far out under the wall—an essential precaution to prevent the recurrence of the pernicious parietal peritoneal adhesion.

#### EXCLUSION OF THE INTESTINES

The next step is to clear away the intestines, stomach, and any other viscera from the operation field and to incarcerate them under the abdominal wall. Here they will be free from injury and will be kept warm. This exclusion of intestines from the operation field by the use of mechanical hands is a very special feature in the technique, and is of great value when the organ is deeply situated and access is difficult, as for instance in the exposure of a contracted and highly situated gall bladder or of the pancreas in a fat person, or of a kidney from the abdominal cavity. This maneuver is carried out by means of large soft veils of a single layer of gauze (a yard by a yard and a half) puckered at one end, and mechanical hands with blades set at an acute angle. The method varies according to the particular operation field but follows to a certain extent some general rules.

The veil is laid on the intestines and the frame (not the retractor) is tilted so that the veil (angled up with the intestines) is drawn into the abdomen. Add several extra layers of the veil and with the hand draw the intestines far out under the abdominal wall. Substitute a mechanical hand for the hand and fix it to the frame. The crumpled up veil acts as a buffer between the mechanical hand and the intestines. Do this on the sides of the frame where it is necessary until the operation field is quite free from the intestines (Fig. 2, 5 and 6, Fig. 3, 7, 8, and 9). As the acute angled blades of the mechanical hands are so made that they fit well under the abdominal wall there should therefore be no infringement by these on the operation area.

#### OPERATIVE EXPOSURES

**Gall bladder.** The precision exactitude, and value of this technique is best seen in a difficult cholecystectomy. Indeed no cholecystectomy can be difficult with it at least that has been our experience. There will be no accidents, such as injury to the common duct.

In the planning of the incision the cystic duct must be regarded as the point of greatest importance—the keystone of the operation and the

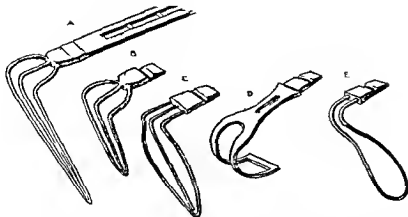


Fig 4 Detachable blades for mechanical hands 4 Long deep blade for special purposes B narrow shallow blade for difficult appendiceal operations and other purposes C blade used for gall bladder pelvic and other work D small blade for use in small wounds such as for acute appendicitis etc and E blade for the urinary bladder

main objective of the operative exposure. For this reason a paramedian incision must be used and made as high as possible. The retractor is now inserted and the wound set in the usual way. The next object is to stretch the gastrohepatic omentum and thus to unravel and straighten out the biliary vessels and ducts. To do this three or four folds of a veil are laid loosely on the second part of the duodenum and by means of a 'mechanical hand' the spine and the surrounding intestines are drawn well over to the left under the abdominal wound. With other mechanical hands and scarves the stomach (use a deep 'hand' for this as in Fig 4 and Fig 3 7) and the colon (Fig 3 8) are drawn out of the way.

If the patient is now put in the reverse Trendelenburg position, the operation area will be flooded with light and dissection of the cystic duct and the gall bladder will be possible under good vision. The exposure is so perfect that it is quite unnecessary to touch or drag on the liver and this means much less postoperative disturbance and nausea.

**Common duct.** While a good exposure of the common duct is necessary for the removal of gall stones, especially in fat people, it is of inestimable value in injuries to the common duct, which as a rule are due to some accident during a cholecystectomy and occur near the hepatic ducts—a situation very difficult for operative manipulation. The gall bladder and common duct are dissected free from any adhesions and the operation wound

is 'set' as usual. It is wise in exposing the duct to stretch the duodenum downward, not over the spine and to push up the liver. To do this it is necessary to use four 'mechanical hands'. Scarves and 'mechanical hands' should, therefore, be used to retract out of the operation area (a) the stomach, (b) the hepatic flexure of the colon, (c) the duodenum and small intestines (d) the liver edge upward. The important retraction is the lifting of the liver, thus stretching, opening up, and exposing the upper part of the common duct for dissection. So as not to injure the liver it is necessary to use a small blade, with extra layers of the soft gauze, and light pressure.

The exposure obtained is surprisingly good; the operation area is 'set' and does not require the annoying constant readjustment necessary in the usual methods. Certainly patience and deliberation are required, but these are amply repaid by the well lighted operation field and by the precision which is possible in the difficult manipulations of the suturing of the hepatic duct into the duodenum or the suturing of a wound in the upper part of the common duct. Here as in all operations on the gall bladder, if a dilated stomach is in the way, it is wise to deflate it with a trocar attached by rubber tubing to a suction pump (Fig 7).

With this exposure it is also quite easy to dislocate the duodenum to probe the common duct and to examine the ampulla of Vater or to carry out any precise dissections or manipulations necessary in this region.

**Stomach.** The oesophageal end of the lesser curvature of the stomach is the point of greatest

<sup>1</sup>This technique has been given much greater detail in Surg. Gynec. & Obst. 19 7 Nov 1939

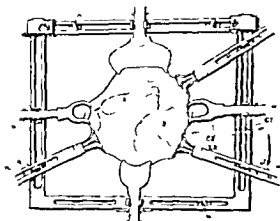


FIG. 5. This is to show how the mechanical hand should be inserted and locked. The hand is inserted loosely at right angles to bar of frame on to the single hook at C. A lateral movement in the direction of the arrow to C will now jim the hand without letting the intestine out.

difficulty in gastric operations it is the most inaccessible—it is important from the point of view of lymphatic infection in carcinoma—it is the starting point for the mobilization of the lesser curvature in contracted and cartilaginous old ulcer. Consequently, we think the main object of any exposure must be this point.

When a left paramedian Bevan's incision has been made:

1. The retractor should be locked in the way described (Fig. 8).

2. The stomach should be deflated by means of a trocar connected to a suction pump (Fig. 7). In the Australasian Medical Congress of 1920 we first drew attention to the great value of this maneuver in difficult operations on gastric conditions.

3. The left lobe of the liver should be covered with some layers of veil which should be hooked over to the right with a mechanical hand (Fig. 8 10). This exposes the upper part of the lesser curvature.

4. The patient is put in the reverse Trendelenburg position so as to throw light into the depths of the wound.

The importance of adequate exposure of this particular region is also stressed because we think that an operation on a carcinoma of the pyloric end of the stomach should not be started in the usual way that is at the pylorus. In our opinion the stomach should be cut across between Payr clamps proximal to the lesion and the distal segment should be allowed to hang over to the right

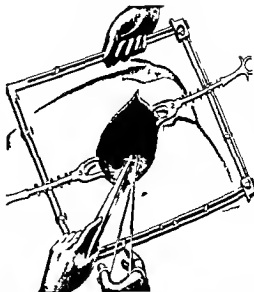


FIG. 6. This shows how in operations in secondary abdominal cases a clear space on each side of the incision is made and how into this clear space two retractors are inserted so that the abdominal wall may be lifted to facilitate the disconnection of adhesion from the anterior abdominal wall.

so that very accurate dissection of the subpyloric glands and of the adjacent pancreas may be carried out. Bruising of these glands is liable to occur when the dissection is started from the pyloric end.

Very great expertness and speed in bowel suturing can be attained if the frame is used to suspend the bowel segments in proper position by systematic catgut retraction. Advantage should be taken of this in making the gastrointestinal anastomosis. The segments of stomach and intestine should be fixed together and to the retractor frame by guy ropes (Fig. 9 1 and 8). This gives a definite tension and a fixed resistance against which suturing may be carried out and this makes for great accuracy and neatness.

Once the retractor is fixed in the wound very light anesthesia suffices for an operation on the insensitive stomach.

*Posterior wall of the stomach—gastric ulcer penetrating the pancreas.* In an operation on the posterior wall of the stomach for a gastric ulcer penetrating the pancreas the following steps are necessary:

1. The wound is set in the way indicated.
2. The stomach is aspirated of air.
3. Large openings are made in the gastro-hepatic and gastrocolic omenta.

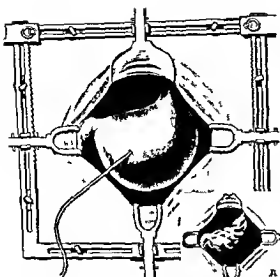


Fig 7. This shows a stomach which is dilated and filled with air being punctured by a trocar attached to a suction pump. The inset 1 shows the stomach collapsed. In this latter condition it is much easier to operate upon and it allows better operative access to organs in the vicinity.

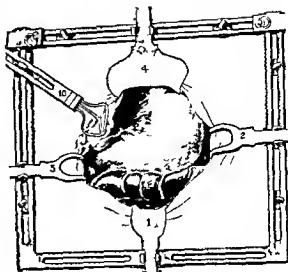


Fig 8. Exposure of the stomach. Retractor 4 is placed in the upper angle of the wound and the left lobe of the liver protected by many layers of gauze is hooked over out of the way of the lesser curve by mechanical hand 10.

4 With a mechanical hand and scarf the transverse colon is held out of the way.

5 The ulcer is exposed and with an aspirating tube a line of cleavage which will be found between the edge of the ulcer and the pancreas is boldly penetrated. The stomach is dried and with the gloved finger the ulcer is shelled off the pancreas. A scarf is drawn through the openings in the gastrohepatic and gastrocolic omenta and drawing on it the posterior wall of the stomach is rotated so that it assumes an anterior position. It is now possible to suture the ulcer in comfort and with precision.

**Pancreas** In the ordinary way the exposure of the pancreatic region is most difficult, as the pancreas is so deep down in the abdomen. Manipulations are hampered by the crowding in of the stomach, colon and the small intestines. With ordinary method it is difficult to light the operation area.

1 The retractor is inserted.

A six inch incision is made in the gastrocolic omentum.

3 A crumpled up veil is placed over the transverse colon and another over the stomach (which has been previously deflated) and perhaps another over the duodenum. With as many mechanical hands as necessary these organs are pushed under the abdominal wall out of the operating area.

4 The area may now be illuminated either by daylight (reverse Trendelenburg position) or by artificial light.

The surgeon will be surprised to find what an enormous difference this exposure makes in operations on the pancreas. Excision of a very large old suppurating pancreatic cyst wall in the head of the pancreas and incision of the capsule in acute pancreatitis, have been easily and satisfactorily dealt with by this method.

**The kidneys from the front** A right upper paramedian incision is made, and the abdominal wound is set in the way that has been indicated (Fig 2). Large folded soft veils are placed over the stomach, ascending colon and the hepatic flexure. With two mechanical hands these structures are drawn toward the midline and the hands are fixed to the median side of the frame. If necessary a low lying liver may be held out of the way with layers of a scarf and a mechanical hand (Fig 10 7). The peritoneum is incised lateral to the hepatic flexure and the upper part of the ascending colon. The mechanical hands are now unlocked on the medial side of the frame and the colon is stripped from the posterior abdominal wall. The mechanical hands reinserted and this loosened segment of the colon incarcerated still farther into the left part of the abdomen. It may be necessary to use a third small mechanical hand on the lower side of the



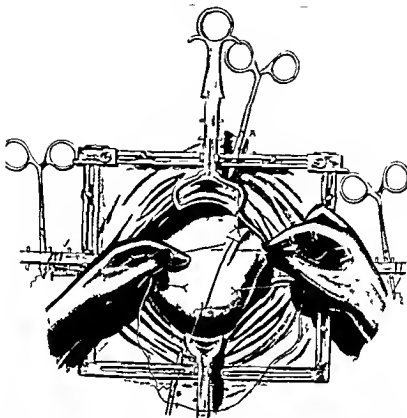


Fig 9 This gives some idea how segments of stomach and intestine can be fixed to the frame by means of guy rope retraction so that exact suturing and accurate adaptation can be obtained and so that suturing can be carried out against constant tension

frame in order to keep any small intestines out of the operating area. It will now be found that the front of the kidney is well exposed and, if the patient is placed in an exaggerated reverse Trendelenburg position the operation area is flooded with light. It is now a very easy matter to isolate the kidney and display its pedicle which may be delivered more naturally forward than backward. A stab wound in the loin will provide the usual drainage.

This is also the exposure for a chronic subhepatic appendicitis.

**Appendiceal region** The average appendectomy gives no trouble, but a good exposure of the appendiceal region is essential and life saving in what one might call the mean appendix that is the acutely inflamed appendix that from a developmental error is anomalously situated as for instance, in the pelvis or in a retrocaecal position the appendix which is intensely inflamed and

gangrenous and undeliverable the appendix that is bound down by the fibrosis resulting from inflammation. In all these conditions adequate operative exposure so as to allow dissection under sight will avoid intestinal soiling shock and bleeding and make for a neat, expeditious operation.

The following is the method of exposure of a retrocaecally placed acutely inflamed appendix.

The ordinary muscle splitting incision is made but the incision is continued in the aponeurosis of the internal oblique and transversalis muscles into the sheath of the rectus (after Professor Watson and Davis) (Fig 11). If the appendix is very inaccessible and more room is required the incision is connected with a vertical incision *B* in the sheath. The edges of the wound are covered with towelling or rough glove rubber sheeting (specially made) or with both. With the retractor the abdominal wound is 'set me

mechanical hands" with small blades being used where necessary (Fig 4, D)

No attempt is made to find the appendix, but by the tracing of the terminal ileum to the cæcum, the ileocaecal junction is located. The base of the appendix nearly always bears a definite relation to this and is isolated and divided by means of a cautery between clamps. The butt is tied and invaginated into the cæcum (Fig 12, A). A crumpled up veil is placed over the cæcum, which, with the hand, is now pushed well under the abdominal wall and so out of the operation area. It is fixed there with a "mechanical hand" (Fig 12, II). Now by the clamping and snipping of what there is of the appendiceal mesentery, G, the appendix itself can gradually be drawn out from under the cæcum without the least tension being put upon it or the slightest force being used. This

'lifting' out of the appendix is important, because very often it is the surgeon who manually enucleating the appendix, ruptures the inflamed, friable appendiceal tip, and distributes infection through the coils of the very susceptible small intestine. When the appendix lies lateral to the cæcum and ascending colon and is very long extending up toward the liver, it is possible, by means of the lifting action of the retractor, to elevate the abdominal wall away from the intestines and to create a space previously only potential. Then when the patient is placed in the reverse Trendelenburg position and the wound becomes sufficiently well lighted, it is possible to dissect out with long instruments one of these long appendices and to clamp its arterial supply.

*Acute pelvic appendicitis* In acute pelvic appendicitis the same wound setting" is used as for the retroperitoneal type of appendix (Fig 12). The base of the appendix is found in the same way (Fig 12 A). Now with "veils" and "mechanical hands" the cæcum is pushed up into the abdomen and the small intestines are cleared from the appendix as it descends into the pelvis (Fig 13, B). If the patient is now placed in the Trendelenburg position, the appendix can be seen the whole way into the pelvis so that unhampered by intestines and under good vision, the appendiceal mesentery (Fig 13 C) can be clamped and snipped with long handled instruments and the appendix itself can be lifted out of the pelvis without the slightest injury. In this way the terminal part of an acutely inflamed pelvic appendix often gangrenous or thin and full of pus, is never ruptured.

It frequently happens that an appendiceal pelvic abscess causes an obstruction of both the small intestine and the sigmoid ileus duplicis (II and

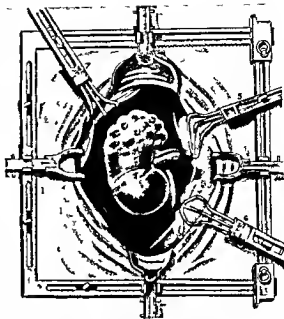


Fig 10 The exposure of a right kidney by the abdominal route. The ascending colon and hepatic flexure covered with layers of gauze are held in the abdominal cavity by mechanical hands 5 and 6. The liver also well protected with many layers of gauze is held up by the gentle tension of mechanical hand 7.

ley). Here the cæcum and the small intestines adjacent to the appendix will be so much dilated that it would be very difficult to give adequate exposure even to a normally situated appendix and certainly next to impossible to remove the deeply situated acutely inflamed, abscessed pelvic appendix. In such circumstances the operation can be made almost easy by the insertion of a hypodermic needle of a slightly larger caliber than usual, connected to an air pump obliquely through the coats of the cæcum (Fig 14, E) and with this withdrawing intestinal gases. This procedure causes the cæcum and the adjacent foot or so of small intestine to collapse (Fig 14, D). The aspiration through such a fine needle is slow, but the content is mostly gas, and it is remarkable how this maneuver simplifies what appears to be an almost impossible appendicectomy.

In difficult appendicectomy in acute cases, we deprecate the use of the paramedian incision and we claim for our technique, that is, the modified "split muscle" incision combined with the use of this special retractor and its "hands" the following advantages:

1. The incision is made directly over the base of the appendix—the best point of attack.

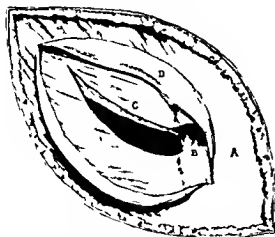


Fig. 11. A modified McBurney incision. 1 The sheath of rectus. B incision in the conjoint tendon continued into the sheath of the rectus and if necessary vertically down the sheath of the rectus (after Davy) and Professor Watson by courtesy Journal of the College of Surgeons of Australasia)

2 The small intestine with its larger and more absorbable lymphatics is not disturbed and soiled as it must be in the manipulations through or in suturing of a midline incision.

3 The pelvis and kidney fossa—most important regions—are accessible by an aspirating and drainage tube with the least disturbance of small intestines.

4 Valvular drainage may be established and loose suturing may be adopted. This avoids infective necrosis of muscle and subsequent hernia.

*The lower end of the ureter.* In operations on the lower end of the ureter in the male when the vas deferens must be conserved a large paramedian incision is not of much advantage. An incision exactly similar to that used for the pelvic appendix may be used except that it should be made an inch above the inguinal canal. The mechanical hands are used in exactly the same way as in the removal of the pelvic appendix except that they are placed outside the peritoneum and the deep mechanical hand (Fig. 4 A) is used in the lower angle. This lower angle of the wound should be at a point an inch above the insertion of the rectus muscle into the pubis. At this point the lower end of the ureter is nearest the surface. The mechanical hands must therefore be utilized to create the biggest cavity in this region.

The ureter is found at the junction of the internal and the external iliac arteries and traced down to the bladder.

The art of the exposure is the creation of a good operating cavity adequately lighted (a good Trendelenburg position will probably do this) right over the lower uterus—that is, in the lower angle of the wound.

In a female where the round ligament can be sacrificed without any hurt to the patient a big paramedian incision will give a more comfortable exposure. In the female in order to create an operating cavity it will be necessary to push the peritoneum toward the middle line with veils and two mechanical hands.

*The pelvis.* This technique is really ideal in operations in the pelvis and makes operations on the rectum and sigmoid very much easier. Retractor A fits neatly over the os pubis (Fig. 1).

The wound is set in the usual way. The upper end of the retractor frame is lifted, the patient is placed in the Trendelenburg position when it will be found that the intestines fall easily out of the pelvis into the main abdominal cavity. Mechanical hands (Fig. 2) are now used to incarcerate them in this situation. The acute angles of the mechanical hands prevent them from encroaching on the operation area. If the rectum or sigmoid is the object of the operation the latter is left lying in the pelvis. If a fibroid is too big to deliver through the retractor it is delivered first and the retractor is inserted afterward.

*Urinary bladder.* The ratchet action mechanical hands and four blade principles of the retractor can be most successfully applied to operations on the urinary bladder such as those for the prostate papilloma or diverticulum.

*Prostate.* For operations on the prostate the movable bar C is adjusted to a position on the frame about the points 1 and B. Mechanical hands (Fig. 15) with blades E (Fig. 4) are inserted into the opening in the bladder. The bladder wound is now opened with the ratchet which may even tear it a little until there is a sufficiently large opening through which to work. Into the upper angle of the wound is inserted a mechanical hand (Fig. 15) with a very acute angled blade which is made somewhat like a soup spoon. This is used to push the fundus of the bladder up into the abdomen so as to draw up any retroprostatic pouch and flatten the base of the bladder and also to bring it nearer to the surface. It is our experience that in a fat person the weight of the intestines makes the fundus of the bladder bulge downward and renders a satisfactory exposure of the prostate difficult. It may be necessary to use a small blade (Fig. 4 D) in the lower angle of the bladder wound in order to give a bet-

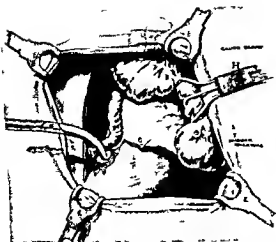


Fig. 12 Exposure for retrocaecal appendix. *A* base of appendix divided and butt invaginated so that caecum *B* covered with a scarf can be pushed into the abdomen with a mechanical hand. *C* arterial twigs being snipped and tied. *D* appendix (retrocaecal) and *E* the abdominal wall is lifted up with the retractor so that the terminal part of the appendix (dotted line) may be removed under good vision. (By courtesy *Journal of the College of Surgeons of Australasia*.)

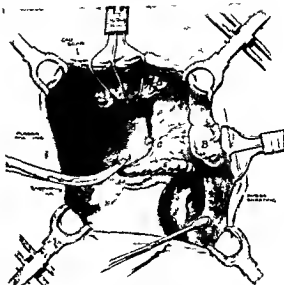


Fig. 13 Exposure for pelvic appendix. *A* base of appendix divided between clamps and invaginated. *B* deflated caecum covered with gauze and held out of operation area with mechanical hand (blade flexed at an acute angle). *C* small intestines covered first with omentum and then with a scarf and excluded from operation area with mechanical hand. *D* arterial twigs in mesentery clamped cut and dried so as to make the appendix come up to the operator. *E* aspirator for perforating the abscess and rapidly and completely removing the pus and *F* pelvic appendix. (By courtesy of *Journal of the College of Surgeons of Australasia*.)

ter view of the anterior margin of the prostatic orifice and to act as counter pressure to the mechanical hand in the fundus.

A small lamp may be screwed into a socket in the middle of the highly silvered spoon mechanical hand (Fig. 15, 3 inset). From the shelter of the fundus this lamp reflects light directly on the prostate and trigone or wherever necessary.

The patient should be placed in the Trendelenburg position.

**Papilloma.** In operations on papilloma of the bladder the exposure will need to be wider and to be contrived so as to suit the situation of the lesion. It may be necessary to insert the blades in a radiate fashion. At any rate they should be so adjusted that the papilloma area is free to be dissected.

**Malignant tumor.** In malignant tumor of the bladder where it may be necessary to resect a large portion of the bladder wall a low median incision is made between the recti and pyramidales and the peritoneum is opened. The retractor is inserted in the usual way and with it the abdominal wall is lifted. The intestines are removed from the pelvis and incarcerated in the main abdominal cavity by means of a veil and two mechanical hands (Fig. 2, 5, and 6).

The patient is placed in the Trendelenburg position. With a trocar and pump the bladder is aspirated. The bladder is opened and dried out

carefully with an aspirator tube. The bladder is isolated and the tumor is resected. As the resection of the tumor proceeds, corresponding or particular parts of the bladder wall should be fixed to the frame by catgut "guy ropes" in order to keep the proper relations for reconstitution of the remnants of the bladder. This allows replanning and easy and exact suture of the much mutilated bladder.

**Diverticulum of the bladder.** 'Guy rope' catgut retraction is particularly valuable in the removal of a very large and adherent diverticulum through the bladder.

The edges of the diverticular opening are freely incised and the neck of the diverticulum separated from the bladder wall. The diverticulum is now freely exposed by the drawing of the bladder wall away from it by a number of guy rope catgut retractions placed symmetrically round the frame. It may even be possible to expose the diverticulum further by the insertion of a couple of narrow deep mechanical hands. By these means the opening in the base of the bladder is set widely open and brought nearer the surface. This

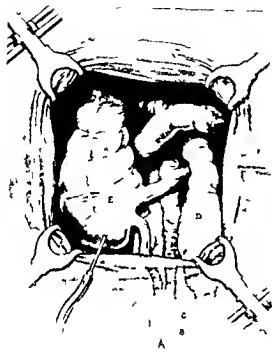


Fig 14 Exposure of pelvic appendicitis with ileus duplex. *A* Infected appendix (dotted in) *B* abscess (shaded in) *C* paralyzed segment of small intestine *D* obstructed small intestine *E* dilated cecum and *F* hypodermic needles attached to air pump deflating cecum

renders it possible, with long scissors and forceps, to dissect out the diverticulum under good vision so that it keeps on coming up to the operator as he snips around the walls.

This system of retraction is also most useful in the extraperitoneal removal of a diverticulum.

#### SUMMARY

We have found that this technique has great potentiality in enabling the surgeon to get out of serious operative difficulties. To every surgeon there must come a time when unexpectedly an almost insurmountable operative problem occurs at an operation or the unexpected happens. For instance, a patient has been operated on for gall stones. No disease of the gall bladder has been found, but examination reveals that the kidney has a dilated pelvis. It is a matter of a few minutes to rearrange the retractors, deliver the kidney into the wound, and explore or deal with the kidney condition without making a fresh incision. Or if a gastric lesion is found, the incision can be

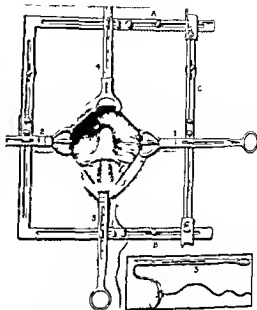


Fig 15 Retractor set in the bladder for exposure of the prostate. Mechanical hands 2 and 3 are used to retract opening in bladder (see Fig 4 *e*). Retractor 4 is seen in Figure 4 *d* and retractor 3 is a spoon shaped mechanical hand with a light in the middle of the highly silvered spoon.

made to expose the whole of the stomach by just rearranging the retractor so that the incision is made wider at the expense of its length. The reverse happens. During an operation for a gastric lesion a pathological condition of the gall bladder is found the gall bladder can be removed without enlarging the incision.

Let us suppose that in operating from the abdomen a hydatid cyst or an abscess of the upper surface of the liver is found then it is possible to elevate the costal arch to press the liver down, and to create a space that enables the surgeon to attack the upper surface of the liver. It is quite unnecessary to go through the pleura. Once the abscess is opened counter drainage at its lowest point can be easily established. In a similar way, access can be obtained to the left side of the diaphragm so that adhesions from a spleen can be severed with a scissors rather than be torn by the hand.

The patient has disease of the gall bladder but needs the removal of the appendix as well. An incision is made as high as possible in the abdomen just sufficiently big to enable the gall bladder to be removed. The abdominal wall is elevated a swab on a holder is pushed against the anterior abdominal wall at McBurney's point from inside

the abdomen. A stab incision is made on to this. With the left hand in the abdomen the appendix is delivered through this stab incision and removed. One stitch closes it. This means that there is an incision very high up in the abdomen and a tiny incision in the lower part of the abdomen—a much better arrangement from the patient's standpoint so far as the strength of his abdominal wall is concerned than the necessarily big incision in the middle of the rectus, made to give access to a high gall bladder and a low appendix, at a point where there is the greatest postural tone.

An appendix is being removed: it is found that the patient has a uterine fibroid. It is an easy matter by the incision of the sheath of the rectus and the re-arrangement of the retractor to elon-

gate the incision so that the fibroid tumor can be removed without a fresh incision being made. A hernia is found: it is possible to close the opening from the inside. Indeed, additional uses are constantly being found in which this method of operating is a distinct advantage.

This technique has to be seen in order that its potentiality and its rationality may be appreciated: but even we who have employed it for years, could not adequately tell our readers what it has meant to the great number of patients on whom we have operated, to the surgeons whom we have initiated into its many uses, and to the assistants and nursing sisters. Any surgeon who would assimilate this method, must cultivate it before he can regard it as part and parcel of his general technique.

FROM THE DEPARTMENT OF SURGERY OF WASHINGTON UNIVERSITY

ARTHRODESIS OF THE SHOULDER BY MEANS OF  
OSIOPIRIOSTAL GRAFTS

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Director, Shriner Hospital for Crippled Children

**A**RTHRODESIS of the shoulder is an operation which is definitely indicated in certain conditions and one which may effect the cure of disease and result in an upper extremity which is very useful as well as free from pain and obvious deformity. However a firm bony ankylosis of the shoulder is difficult to obtain because when the shallow glenoid is denuded the area of raw bone obtained is disproportionately small in comparison to the head of the humerus to which it must be opposed. A further difficulty is that the scapula is movable on the thorax and cannot be completely immobilized by any form of apparatus. Consequently the usual type of arthrodesis operation often results in a complete failure or only a fibrous ankylosis of the shoulder is obtained. The difficulty is partly overcome by collapsing the denuded or split acromion on the upper end of the humerus but even this type of operation is often unsuccessful.

In this paper an operation is described which offers a better chance of success than any other with which I am familiar. It is similar to a procedure which I described in 1916 for the treatment of tuberculosis of the hip.<sup>1</sup> The advantages of the operation are that it gives a complete exposure of the shoulder joint thus enabling the surgeon to perform a thorough operation and it supplies extra bone at the points where needed.

## INDICATIONS FOR THE OPERATION

The chief indications for arthrodesis are tuberculosis of the shoulder joint, complete and permanent paralysis of the deltoid and certain chronic painful conditions of the shoulder which cannot be relieved by less radical methods. A brief explanation of these indications follows.

Many competent orthopedic surgeons believe that tuberculosis of large joints is most satisfactorily treated by conservative methods especially heliotherapy. These men will, of course, not consider this or any other extensive operation in tuberculosis of the shoulder. Personally I have never seen a case of proved tuberculosis of a large joint in an adolescent or adult cured with a useful

range of motion in the joint. Consequently, I recommend arthrodesis as soon as the diagnosis is definite and patient is ready for operation.

The paralyses of the deltoid are usually the result of poliomyelitis and in these cases there is often extensive paralysis of the entire upper extremity. It is almost useless to operate on cases in which immobilization of the shoulder in a good functional position will not materially benefit the patient. For this reason one should operate only upon the patient who has sufficient muscle power in the arm and the forearm to give him a hand which would be useful if it could be properly controlled. It is also necessary that the patient have sufficient power in the shoulder girdle muscles especially the trapezius and serratus magnus to control the movements of the scapula.

The painful arthritic conditions of the shoulder which warrant such a serious procedure as arthrodesis are usually the result of an old fracture involving either the head of the humerus or the glenoid in which the fragments are healed in malposition and the mechanics of the joint are disorganized. In these cases the operator can feel that he is not liable to do any harm as there is rarely enough motion left in the joint to be of use to the patient but just enough to cause frequent attacks of pain which may or may not radiate down the extremity. Before resorting to arthrodesis in these cases of so-called traumatic arthritis the surgeon should endeavor to relieve the patient by immobilization in a good functional position and by physiotherapy (local heat and also massage). As a rule conservative treatment should be continued from 6 months to 1 year before an arthrodesis is performed in a case of traumatic arthritis of the shoulder.

The object of the operation is to fix the humerus to the scapula in such a position that the arm can be elevated to the level of the shoulder or be proximated to the side. This amount of motion is accomplished by the movements of the scapula on the trunk. There is also a certain amount of rotation of the arm and backward and forward motion which is obtained in the same manner. In the case of infantile paralysis with total paralysis of the deltoid the abduction and elevation of

Key, J. A.: Treatment of tuberculosis of the hip. J. Missouri St. M. Assn. 1916, November, 3<sup>rd</sup> 397.



Fig. 1 Split plaster jacket with spica trough for arm prepared before the operation

the arm obtained by the patient are practically all due to the operation

#### PREPARATION FOR THE OPERATION

If the shoulder is movable and can be abducted to the desired functional position it is wise to apply before the operation a plaster spica jacket which fits well around the iliac crest and includes the shoulder and arm down to the elbow. This will shorten the length of time which the patient must spend under the anæsthetic and the jacket can be applied while he is able to sit or stand. It is applied with the arm abducted 70 to 90 degrees and brought forward about 30 degrees from the frontal plane so that the hand can reach the face. The top of the plaster covering the arm and shoulder is then removed and the plaster jacket is split on the opposite side and removed. The top is discarded but the plaster jacket with the trough for the arm is saved in order that it may be applied after the operation (Fig. 1). It is useless to include the elbow and forearm in the preliminary plaster because the operation shortens the upper arm slightly and the flexed elbow and forearm will therefore not fit in the trough which has been prepared for them.

After the cast is made the operative fields are given a 48 hour preparation. On the first day the entire arm and shoulder region including the axilla is shaved and scrubbed with soap and water then it is washed with alcohol and ether and a sterile dressing is applied. As it is convenient to procure the bone grafts from the tibia of the leg on the opposite side this leg is then prepared in a similar manner. The scrubbing with soap and water followed by alcohol and ether and the application of a sterile dressing are repeated on the second day.



Fig. 2 Position of patient on the table with shoulder elevated. The black line shows the site of the skin incision

#### TECHNIQUE OF THE OPERATION

The patient is placed on the table, anesthetized with ether and turned on the opposite side with the shoulder facing directly upward, large sand bags are placed next to the back and chest to maintain the position (Fig. 2). The arm is draped in such a manner that it may be moved freely. Sterile stockinette has been found convenient for this purpose. The leg and foot also may be covered with stockinette. Since the operation may be rather long and difficult and since it is always well to be ready to proceed to the conclusion of a major surgical procedure should the patient show symptoms of shock it is preferable to remove the grafts from the tibia before the operation on the shoulder is started.

A long straight incision is made over the middle of the subcutaneous surface of the tibia extending



Fig. 3 Outline of skin incision. The black dot is placed over the tip of the acromion



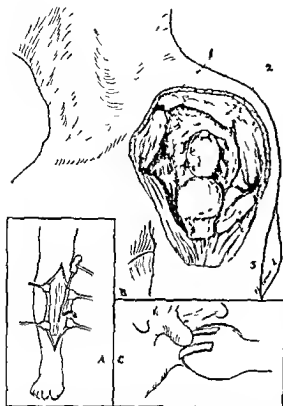


Fig. 4 Exposure by Codman's incision. 1 Methods of removing grafts from the tibia. 2 The glenoid prepared for the reception of the head of the humerus. 3 Acromial end of clavicle. 4 Base of acromion cut by saw and 5 detached acromion. C Relation of grafts to humerus.

from the level of the tubercle down to the lower fourth of the leg. This is carried down to the periosteum and the skin and subcutaneous tissue are dissected back on either side. Then with a knife four parallel incisions are made in the periosteum. These are about  $\frac{1}{2}$  inch apart and include practically all of the subcutaneous surface of the bone. Transverse incisions in the periosteum are made at either end of the vertical incisions. With a small curved chisel, the osteoperiosteal grafts are then removed in such a manner that a thin layer of cortical bone is raised with the strip of periosteum. Three such strips are cut and placed in a bowl which is covered and kept sterile. (I do not wrap these grafts in sponges saturated with salt solution as I believe that this may injure the cells, but simply use a gauze soaked with blood from the wound and since the bowl is covered, the grafts are thus in a moist chamber.) An assistant closes the wound in the leg while the operator devotes his attention to the shoulder.

In order that the operation may be performed thoroughly, it is necessary that an adequate exposure of the shoulder joint be obtained. For this purpose I prefer the saber cut, devised by Codman<sup>1</sup> originally for suture of the supraspinatus tendon but ideal for arthrodesis of the shoulder as it gives a complete exposure of the joint. The saber cut incision for arthrodesis provides an incision a little more extensive than that described by Codman but the lines and principles are identical.

The skin incision begins in front opposite the lower border of the glenoid and extends straight across the shoulder from before backward directly over the acromioclavicular joint to a similar level behind (Figs. 2 and 3). The incision is carried down to the bone and muscle, and after the superficial bleeding points have been clamped skin towels are applied. The anterior and posterior portions of the deltoid are split rather than detached from the clavicle and spine of the scapula. The acromion is separated from the clavicle at the acromioclavicular joint by dividing the capsule of that joint and is then sawed through at its base in the line of the incision, thus detaching the acromion with the flap or epaulet consisting of the lateral portions of the deltoid, together with the skin and subcutaneous tissues. This is retracted outward to expose the subacromial bursa and the superior portion of the capsule of the shoulder joint. The upper portion of the capsule and the loose subacromial tissue are excised en masse, thus exposing the joint. The tendons of the supraspinatus and the infraspinatus are retracted backward while that of the long head of the biceps is detached from the upper border of the glenoid and sutured to its sheath in the depth of the wound. The synovial lining of the joint is then excised by sharp dissection.

After the synovial membrane and diseased tissues have been removed the head of the humerus and the glenoid are completely denuded of cartilage and diseased bone with a curved chisel or gouge, and the periosteum is raised from the upper end of the shaft of the humerus and from the scapula around the margins of the glenoid. If the glenoid is much eroded the base of the acromion is also denuded and the nerve to the infraspinatus is ruthlessly disregarded as the muscle will be useless anyway if the operation is successful. The same is true of the tendon of the supraspinatus if it interferes with bone-to-bone opposition between the upper end of the humerus and the lower surface of the acromion. As a rule it is loosened from its insertion and pushed back.

Codman, E. Oblique lesion of the shoulder ruptured the supraspinatus tendon. Boston M. & S. J. 9: 7, 1913.



Fig 5 Postoperative plaster jacket showing position of arm and shoulder

ward. Imostats which were placed on bleeding points during the operation are now removed, and usually it will not be necessary to tie any vessels. The periosteum is now removed from the deep surface of the detached tip of the acromion in order that it may be approximated to the denuded upper surface of the humerus. With a small drill a hole is made through this fragment and through the base of the acromion at a point opposite for the placing of the suture to hold the fragment in place.

The osteoperiosteal grafts, cut in lengths of about 2 inches are now inserted as thickly as possible around the borders of the glenoid beneath the elevated periosteum of the scapula with their free ends sticking out like the fingers of a half closed hand to receive the denuded head of the humerus (Fig 4). The deep or bone surface of the grafts faces inward to make contact with the denuded upper end of the humerus. All of the grafts available are used and several more than are shown in the drawing are placed around the glenoid spanning the space between its margins and the head of the humerus.

The humerus is then placed against the glenoid and in tuberculous patients a small stab incision is made in the skin of the outer surface of the upper arm at a point about 3 inches below the upper end of the humerus. With the humerus held against the denuded glenoid and in the desired functional position, a large nail is introduced through the stab incision and driven through the

upper end of the humerus in such a manner that its point enters the glenoid as near its center as possible. The arm meanwhile is held in a position of abduction of about 90 degrees and anterior flexion of about 25 degrees. In non tuberculous patients the nail will not be necessary, and in tuberculous patients in whom the entire head of the bone is destroyed it will not be practical, as it cannot be driven through thick cortical bone.

It is important from this time on to move the arm as little as possible. The acromion is now sutured to the clavicle by means of chromic catgut, and another piece of chromic catgut is passed through the holes in its tip and in the base of the



Fig 6 Postoperative arthrodesis of shoulder in a case of infantile paralysis showing a bony ankylosis of the humerus to both the acromion and the glenoid

acromion and tied tightly thus permitting the acromion to collapse upon the denuded lateral surface of the upper end of the humerus. Interrupted subcutaneous sutures of plain catgut are used to close the wound and continuous silk suture to close the skin. No drainage is used. A snugly fitting dry dressing is applied. One or two 5 yard gauze rolls are used to make a firm figure-of-eight bandage to compress the tissues around the shoulder. This lessens postoperative oozing and hastens healing in addition to securing more adequate immobilization in the plaster. The split plaster jacket is now slipped upon the patient care being taken not to disturb the position of the shoulder any more than necessary and the arm is placed in the plaster trough. The forearm and hand are covered with sheet cotton and plaster bandages are placed around the trough and over the arm and shoulder in order to immobilize the part. The elbow is flexed to 90 degrees the forearm is supinated and the plaster is extended to the base of the fingers (Fig 5). Plaster bandages are placed around the jacket to strengthen it. The head of the nail is left protruding through the skin and through the plaster. If the plaster jacket with the shell for the arm has not been prepared beforehand it is of course necessary to apply the entire plaster while the patient is under the anæsthetic. If this is to be done on the ordinary Hawley table the operation should be performed with the patient reversed on the table that is with the patient's head at the foot of the table so that when the

operation is finished, the sand bags can be removed and the patient turned on his back with the pelvic rest between the shoulders. It is of course necessary for someone to support his head when the table is lowered and jacket is being applied.

The position of optimum function for ankylosis of the shoulder is usually given as 75 degrees of abduction for children and 50 degrees for adults with the arm slightly forward from the frontal plane. I use the 90-degree abduction for the first plaster because it enables one to push the humerus firmly against the glenoid while the plaster is being applied and because some abduction is always lost during the period of consolidation.

#### AFTER TREATMENT

The patient may be permitted to sit up in bed on the day after the operation and may be ambulant as soon as his strength permits. At the end of 12 or 14 days the plaster jacket is removed and the wound is dressed. The stitches are removed and a new plaster jacket is applied. The nail is removed about a week later and the second plaster is left on about 3 months. At the end of this time it is removed and an X-ray picture is taken. If there seems to be firm bony union (Fig 6) an abduction splint or removable plaster is fitted and the patient is permitted to exercise the arm. In the case of a tuberculous joint it is better to continue the solid plaster for at least 6 months after the operation before attempting motion. The movable support should be worn for at least 3 months after removal of the plaster.

## HEMINEPHRECTOMY OR RESECTION OF A PART OF THE KIDNEY

REPORT OF FOUR CASES<sup>1</sup>WALTMAN WALTERS M.D. F.A.C.S. ROCHESTER MINNESOTA  
Division of Surgery The Mayo Clinic

**I**DFAL cases for heminephrectomy would seem to be those in which there is complete duplication of the renal pelvis and ureter and in which it is necessary to remove only the portion of the kidney involved by the lesion. Large solitary cysts of the kidney form a second group of cases in which the portion of the kidney containing the cyst should be resected whenever possible, in stead of the entire kidney being removed. McKim and Smith reported from the literature 34 resections of the kidney for solitary cyst with recovery in 31 cases. This should indicate without further emphasis the value of conservative operation whenever possible in such cases.

I shall report 3 cases in which successful resection of the diseased portion of a duplicated kidney was carried out, and also 1 resection of the lower pole of a kidney containing a large solitary cyst. The technique used in the resections will be described. Success depends on the avoidance of opening into the adjacent calyx of the remaining portion of the kidney, and on the assurance of complete hemostasis at the site of the resection. To avoid the former, I have found it an advance after beginning the resection, to place a finger in the dilated calyx and pelvis of the portion to be resected so as to assist in determining its outer limits. It has not seemed necessary during the resection even temporarily to interfere with the blood supply to the remaining portion of the kidney. Immediate bleeding from the cut renal parenchyma ceases quickly with the placing and tying of mattress sutures over small bits of muscle tissue and approximation of the cut edges of the kidney. One may be assisted in this maneuver by making a V shaped resection if possible. Pieces of muscle are used to prevent the mattress suture from tearing through the parenchyma; it is surprising how much pressure can be used in bringing the edges of the kidney together (Fig. 1, c). In 3 of the cases such excellent approximation was obtained that after the mattress sutures were placed I was able to approximate the edges of the fibrous capsule with a running suture (Fig. 1, d). In one instance in which this was not possible the denuded area of the kidney was covered with a portion of the perirenal fat in the form of a patch (Fig. 1, e).

Studies were made pre-operatively and post operatively of the function of each kidney separately and pyelograms were made of the duplicated kidney. Since details of such procedures have been reported elsewhere, I shall merely say that resection of the diseased portion of the kidney did not interfere with the function of the remaining portion and that resection has been followed in each instance by excellent results (Fig. 2, Case 2).

**CASE 1.** A woman aged 38 years had attacks of pain in the right side of the abdomen with chills and fever and pyuria since August 1918. When she was examined November 19 1928 marked secondary anemia was found and the urine contained pus graded 3. Cystoscopic and pyelographic examination on November 22 revealed complete duplication of the left renal pelvis and ureter. Dilatation of the lower pelvis was graded 3; it contained infected urine graded 4. The upper pelvis apparently was normal; the return of indigo-carmin was graded 3. There was no return from the lower pelvis. Excretion of indigo-carmin from the right kidney was graded 4.

On December 28 1928 the lower infected hydronephrotic segment of the left kidney and its pelvis were removed. Nephropexy of the remaining segment was done. The postoperative course was uneventful. Cystoscopic examination January 15 1929 showed a return of indigo-carmin from the right kidney graded 4 and from the remaining portion of the left kidney graded 3. A pyelogram of the remaining segment of the left kidney was similar to that before operation; it was not grossly abnormal. At examination on May 3 the patient was found to be in excellent condition; she was gaining in weight and felt well. Urine from the bladder contained pus graded 1. On July 22 1929 the hemoglobin had increased from 60 to 75 per cent (Dare) and the erythrocytes had risen to 4 150 000. She had been free of pain had gained in weight and was in excellent condition.

**CASE 2.** A man aged 43 years complained of periodic dysuria with gross pyuria and hematuria that had been present since childhood. The urine contained pus graded 4 and the phenolsulphonphthalein return was 70 per cent in 2 hours. The blood urea was estimated as 30 milligrams for each 100 cubic centimeters. Cystoscopic and pyelographic examination on January 2 1929 revealed complete duplication of the right renal pelvis and ureter. The lower pelvis and its calyces were dilated graded 3; the upper pelvis was normal (Fig. 1, a). Urine from the upper pelvis contained pus graded 1; from the lower pelvis it was graded 3. The left kidney contained pus graded 2.

The lower pelvis of the duplicated right kidney was resected on January 22. The pelvis was saccular and when not distended measured 5 centimeters in diameter (Fig. 1, b). Its ureter was three times normal size. Ureteropelvic obstruction was not demonstrable. Postoperative course was uneventful. On February 12 urine from remaining portion of right kidney contained pus graded 1; incision had healed and patient's condition was excellent.

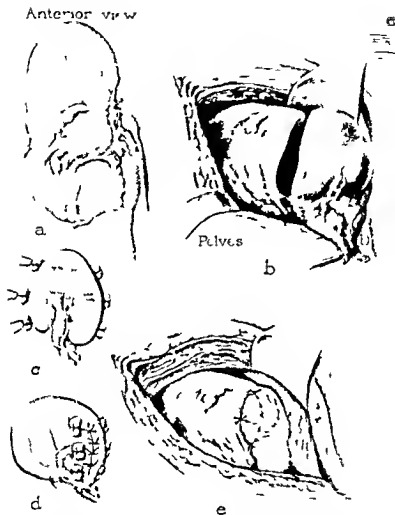


Fig. 1. a and b Hemimphrectomy or resection of the lower infected hydronephrotic portion of the right kidney. c Approximation of cut edge of remaining kidney by mattress sutures tied over bundles of muscle. d Closure of renal capsule by suture and e the use of a patch of perirenal fat when the cut end of kidney can be closed as in d.

**CASE 3.** A woman aged 29 years had complained of abdominal distress for a number of years. A lump had been discovered on examination. Cystoscopic and pyelographic examination on April 15, 1919, revealed complete duplication of the right renal pelvis and ureter; the lower of the two portions appeared normal. Dilatation of the upper portion was graded 2 and the calyces were obliterated. Dilatation of the corresponding ureter was graded 4 throughout its course. Moderate infection was present. Indigocarmine was not excreted from the upper pelvis of the right kidney, but from the lower pelvis excretion was graded 4. Excretion from the left kidney was also graded 4.

On April 25 the atrophic infected upper portion of the right kidney and part of the ureter were removed (Fig. 3).

An anomalous renal artery and vein crossed both ureters. They were not divided because they appeared to constitute the entire blood supply of the lower portion of the kidney which seemed normal and was preserved (Fig. 4). Post-operative convalescence was normal. Cystoscopic and pyelographic examination about 6 weeks later showed the outline of the remaining segment of the right kidney to be the same as before operation, with slight clubbing of the calyces. The function of the remaining segment of the right kidney was reported to be normal. Excretion of indigocarmine was graded 4. Urinary infection was not present.

**CASE 4.** This case is included in the series since the type of resection performed was similar to that used in

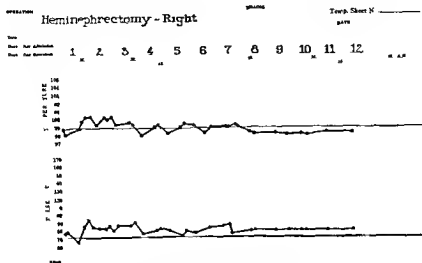


Fig. 2 Case 2 Temperature chart

heminephrectomy and because pre-operative (Fig. 5) and postoperative (Fig. 6) pyelograms with a lapse of 8 months between have been made.

In October 1926 a woman aged 50 years noticed a lump in the left side of the abdomen which was more painful when she moved. The mass had increased in size steadily. In April 1928 the feet and ankles had begun to swell. In the last 3 or 4 months before examination at the clinic the abdomen had increased in size and she had been told by her physician that this was due to ascites.

In the left side of the abdomen a mass was palpated which extended for 5 centimeters below the level of the umbilicus. It was freely movable and approximately 10 centimeters in diameter. The urine contained pus, graded 1. The blood count was normal. The Wassermann reaction of the blood

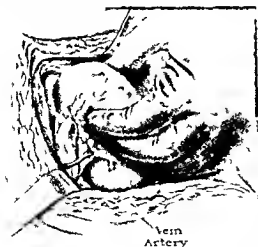


Fig. 3 Case 3 Removal of the upper infected hydronephrotic portion of the duplicated kidney on the right side

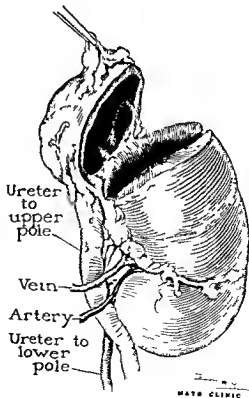


Fig. 4 Case 3 Anomalous artery and vein the only blood supply to the normal lower segment of the duplicated right kidney



Fig 5 Case 4. Pyelogram before resection of a large solitary cyst in the lower pole of the left kidney

was negative. Roentgenograms of the kidneys, ureters and bladder showed a circumscribed shadow in the region of the lower pole of the left kidney opposite the second and third lumbar vertebrae. Cystoscopic examination was performed

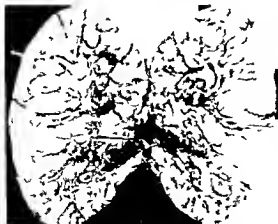


Fig 7 Kidney removed on eighth day because of hemorrhage. Resection of the lower pole had been done and a solitary cyst removed. Attention is called to the healed cortex of the lower pole of the kidney at the site of the resection and the sclerotic open mouthed blood vessels in the calyces



Fig 6 Pyelogram 8 months after resection of the cyst and the lower pole of the kidney

on October 22. The pyelogram of the left kidney was normal save for the lower calyx which was elongated and flattened on a spherical shadow of the mass. The function of both kidneys was normal. The left kidney was not infected.

On October 16 operation was performed through a left lumbar incision with resection of the lower pole of the left kidney and removal of a solitary serous cyst which was distended to 15 centimeters in diameter and contained approximately 300 cubic centimeters of straw colored fluid. The remainder of the kidney was normal in size and consistency. It seemed advisable to remove only the lower portion containing the cyst which was done with reconstruction of the lower pole by mattress sutures tied over small bundles of muscle. The cut edges were brought together completely and the capsule was sutured. The postoperative convalescence was uneventful. The patient was dismissed from the hospital October 9, 13 days after operation.

On June 6, 1919 the patient returned for examination. The urine was normal. Roentgenograms of the kidneys, ureters and bladder were negative. Cystoscopic examination showed a bird type of pelvis with ptosis graded 1; the pelvis was otherwise normal. The ureter was normal. The patient's general condition was excellent.

Since this article was handed in for publication two additional resections of the kidney have been performed in one case of hydronephrosis of the lower segment of a duplicated kidney and in one of solitary cyst of the kidney.

The patient with hydronephrosis was a woman aged 39 years. The infected hydronephrotic segment (lower) of the left kidney was removed.

In the second case the patient was a woman aged 64 years. A large solitary cyst of the lower pole of the left kidney was resected. Eight days after ward nephrectomy was performed because of continuous hæmaturia. Examination of the removed kidney showed that the bleeding was due to sclerotic open mouthed branches of the renal artery (Fig 7). The patient recovered, but the corollary seems to be that plastic procedures on the kidneys of elderly patients with arteriosclerosis may be a radical rather than a conservative procedure.

Successful heminephrectomy or resection of a part of a kidney has been reported by Albarran, W J Mayo, Young and Davis, and Rumpel. Albarran's patient was operated on in 1905. Gayet, in 1912, reported heminephrectomy in a case of duplicated kidney from which the patient recovered in 3 months. At that time, 17 cases had been reported in the literature. According to Young and Davis the 3 resections of the kidney, performed by W J Mayo and reported by Braasch in 1912, were probably the first successful operations of the kind reported in this country. Young and Davis reported successful heminephrectomy (removal of the portion of a duplicated kidney containing a calculus) in 1917. At that

time, they were able to find only 26 cases in the literature in which operation had been done for complete duplication of the renal pelvis and for different grades of ureteral duplication. In 20 of these nephrectomy had been performed. They stated that in 16 of these double kidneys, half of the kidney was normal and that partial nephrectomy could have been performed. They gave a detailed description of the embryological development of this abnormality.

## BIBLIOGRAPHY

- 1 ALBARRAN. Quoted by Young and Davis.
- 2 BRAASCH W F. The clinical diagnosis of congenital anomaly in the kidney and ureter. *Ann Surg* 1912 **li** 726-737.
- 3 GAYET. Quoted by LOUX H R. Plastic surgery of the kidney pelvis and the ureters. *J Am M Ass* 1915 **lvi** 1237-1243.
- 4 MAYO W J. Quoted by Braasch.
- 5 MCKIM G F and SMITH P C. Solitary serous cysts of the kidney. *J Urol* 1924 **xli** 635-661.
- 6 WALTERS WALTERMAN and BRAASCH W F. Urinary obstruction and hydronephrosis: resection of the renal pelvis, the kidney and the ureter. Report of nine cases. *J Am M Ass* 1929 **xciii** 1710-1715.
- 7 YOUNG H H and DAVIS F C. Double ureter and kidney with calculous pyonephrosis of one half: cure by resection. The embryology and surgery of double ureter and kidney. *J Urol*, 1917 **i** 17-57.



## USE OF ULTRAVIOLET LIGHT IN THE PREPARATION OF INFECTED GRANULATION TISSUE FOR SKIN GRAFTING, THE VALUE OF VERY THICK THIERSCH GRAFTS

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In the Department of Surgery, Indiana University School of Medicine

**T**ill grafting of skin on infected granulation tissue has always been attended by a great number of failures. When the areas involved are large it has often required many months to cover them. Following repeated failures, the persistent infection and increasing cicatrization of the wound render the surface progressively less favorable for the growth of epithelium. We believe that the method of skin grafting we are about to describe is a distinct improvement over those commonly in use. In our hands it has been almost uniformly successful and has brought about a great improvement in our results.

Granulating surfaces resulting from third degree burns or injuries which destroy large areas of skin are always infected. If healing has been delayed by the great size of the wound or by excessive sloughing the granulations are oedematous and poorly supplied with blood. In cases of very long standing, the wound presents the appearance of a callous ulcer with a thick base of poorly vascularized scar tissue underlying cyanotic indolent granulations over which epithelium grows poorly or not at all. It is evident that under these conditions skin grafts will not grow. The blood supply must be revived and the infection must be overcome.

### PREPARATION OF GRANULATION TISSUE

The steps in preparation of the surface to be grafted will vary according to existing conditions. If the patient is anæmic or debilitated blood transfusion may be necessary to raise his general resistance. For an infected or sloughing wound we first employ intermittent soaking in normal or hypertonic salt solution with continuous wet dressings of 1½ per cent chlorazene solution. The dressings are changed daily. If during the stage of sloughing the granulations become oedematous and indolent they may be scraped away and given a fresh start. Often, however, we have found that such granulations may be rendered firm and vascular by means of a pressure dressing of dry gauze compressed against the wound with elastic bandage or adhesive tape.

When the wound is of too long standing with a resulting thick fibrous base, it is necessary to

excise this tissue completely and allow a thin layer of granulations to develop on healthy tissue. The same procedures are essential in the correction of extensive scar contractures where wide excisions are necessary to relieve deformity.

When in any case these measures have insured an adequate blood supply to the granulations, the problem of infection is still to be dealt with. In the presence of purulent exudates, the grafts are floated loose and destroyed by proteolytic ferments. Even with lesser degrees of infection such that the granulations are covered by a thin whitish scum of coagulum grafting is liable to fail. The tissue must be firm, beefy, red and clean.

### THE USE OF ULTRAVIOLET LIGHT

It occurred to us 3 years ago that superficial infection in granulation tissue might be effectively reduced by exposure to ultraviolet light. This idea was suggested by the use of ultraviolet light to sterilize water. Our observations lead us to believe that granulation tissue should not be subjected to heavy exposure. Accurate judgment as to the duration and number of treatments is acquired only by experience. Each case is an individual problem and treatment will vary accordingly. We have used air cooled lamps of standard make, average voltage 70 at close range (10 inch distance). The time of any one exposure may be as great as 5 minutes where the granulations are in a bad state. Treatments are given daily and the time is reduced to 1 or 2 minutes as the surface improves. It may also be desirable to secure a milder action by removing the lamp to a greater distance. The normal reaction is one which renders the granulations red, vascular and surprisingly free from exudates.

### ADVANTAGES OF THE THIERSCH GRAFT

When by the procedures just described, a thin but firm bed of beefy red non infected granulation tissue has been built up and when a thin blue line of growing epithelium can be seen at the edges of the raw area conditions are right for skin grafting. The question of what type of graft to employ must now be considered. The ordinary



Fig. 1. Case 1. Three views showing result 6 months after Thiersch grafting extensive third degree burns of the legs.

Thiersch graft has been favored by most authors for the covering of areas on the body which will not be subjected to trauma. The whole thickness graft or the pedicle graft has always been favored for regions in which a good cosmetic effect is desirable or in which the graft will have to withstand constant trauma.

Our experience has shown us that a very thick Thiersch graft placed on granulations prepared as advised will give under any conditions as good cosmetic and functional results as a whole thickness free transplant. The thick Thiersch graft obviously cannot entirely replace pedicle grafts in cases in which it is necessary to transplant whole skin with subcutaneous fat. The indications for and the limitations of this type of plastic surgery are not included in the scope of this paper. Whole skin free transplant grafts however especially if the size is large seem to us to be biologically unsound. They are very disfiguring to the area from which the skin is cut and are furthermore prone to fail because of poor viability.

For these reasons the Thiersch graft is by far the more useful type of free skin transplant. Thiersch grafting both takes and leaves epithelium. The ordinary Thiersch graft should be cut

so that the papillary layer of the skin is bisected. The cut surface heals spontaneously by generating epithelium which appears only slightly different from normal. By this technique large areas of



Fig. 2. Case 2. Two views of chronic popliteal ulcer healed by thick Thiersch graft. Appearance 9 days following graft and result at end of 2 months.

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From the Department of Surgery and the University School of Medicine

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and effectively discourages the exudates which otherwise tend to lift the grafts. Exudates which escape around them are absorbed into the superimposed layers of gauze. Because of this advantage, we do not favor the use of sheet rubber, oiled silk, or any other non absorbent material as an initial dressing. There need be no fear that the gauze will stick and pull loose the grafts. At the end of 5 to 7 days, when the dressing is changed all viable grafts have grown firmly in place. The outer dressings are removed and the gauze soaked loose with physiological salt solution.

Subsequently we employ ordinary dressings wet with salt solution and changed daily, until the wound is again clean and growing epithelium is seen. A thin outer layer of the graft will peel off in the same manner that cornified epithelium normally sheds itself. All the growing layers remain intact and proliferation from the edges is prompt. At this stage vaseline gauze may be employed as the dressing until healing is complete. Vaseline gauze also makes an excellent dressing for the surface from which grafts have been cut. Grease dressings are never advisable on granulations which are being prepared for grafting. In general the treatment best suited for the preparation of granulation tissue is more or less discouraging to the growth of new epithelium. For this reason, an entire area should be prepared carefully to insure success. If there is doubt and the surface is great, test grafting of a small part is advisable. Otherwise the entire area should be grafted at one operation.

When the skin grafts have been placed upon areas of the body not suited to pressure dressings we employ with good success an open method of treatment, protecting the grafts by a cage of screen wire for 3 or 4 days until they adhere firmly. Whenever possible, we prefer the pressure dressing for reasons already given. It is especially applicable for extremities. It should be noted further that whenever the grafted wound involves the flexure surface of a joint, full extension should be maintained until healing is complete. If there is any tendency to contracture the splint should be continued until all tendency to cicatrization has ceased. Children are especially prone to contracture. Splints are indispensable. If contracture is permitted, deformity is inevitable.

#### RESULTS

A successful Thiersch graft, such as we have uniformly obtained by this technique results in an epithelial covering far superior to the cicatrix which must result from prolonged granulation

This grafted skin acquires a soft velvet like contour and a flexibility which closely approximates the normal. Hairs are absent and there may be a slight increase in pigmentation. As time elapses the disfigurement becomes progressively less noticeable. Especially is this true of children in whom repair processes are most active. We have carried out these procedures in a large series of cases with most gratifying results. Approximately 100 patients have had skin grafting operations after radical mastectomy without a failure. In a number of extensive third degree burns we have produced healing with a minimal amount of scar and a minimum loss of time, the interval ordinarily not exceeding 2 months. Some of the possibilities of this technique are exemplified in the three cases reported herewith.

Case 1 is a man who was saved from death or permanent disability by massive skin grafting operations. The chief problem was to combat infection and prepare large granulating surfaces for grafting. Massive failure would have meant a loss impossible to restore. Homografting, that is, from one individual to another has never been successful to our knowledge. It is not within the scope of this paper to enter further into this subject except to regard homografting as a biological problem as yet unsolved. With a successful technique of Thiersch grafting, the necessity of securing a skin donor should be rare indeed.

Case 2 is a man disabled for 4 years because of unsuccessful skin grafting. Following the proper removal of the accumulated scar tissue, a well managed Thiersch graft gave a splendid result where a pedicled graft and whole skin transplants had failed.

Case 3 shows the extent of deformity which may arise from a burn scar contracture, emphasizes the urgency of maintaining extension, and demonstrates further the indications for Thiersch grafting.

CASE 1. No. 2545. Orville C. aged 33 years was admitted to the Robert W. Long Hospital October 6, 1927, in a state of extreme emaciation with extensive third degree burns of 4 months duration. As the result of an explosion in a paint and lacquer shop both his legs had been burned from trochanters to ankles. The areas of first and second degree burn had healed. There remained large areas of third degree burn involving more than half of each leg on inner and posterior surfaces. In these regions there was unhealthy granulation tissue covered with purulent exudate.

He was emaciated and prostrated with septic temperature and rapid pulse from prolonged infection. The granulations were given daily exposure to ultraviolet light and frequent dressings with a 1 per cent chlorazene solution. Due to these measures and a blood transfusion his condition rapidly improved. By the technique we have described the granulations were covered with Thiersch grafts of good



FIG. 3. Case 3. Two views taken before grafting. Leg deformity as shown. Web contracture of knee. Muscle contracture at hip due to bad position. View at right shows appearance 3 weeks following excision of scar and division of hamstring tendons.



FIG. 4. Case 3. Two views showing result 6 months after Thiersch graft. Deformity corrected. The scar is covered with pliable skin and there is complete restoration of function. Leg can be fully flexed and extended.

growing epithelium are placed in close contact with a rich capillary bed of healthy granulation tissue. Since epithelium is a tissue which normally grows upon granulations and normally is nourished by osmosis permanent viability should be possible. It occurs to us that in the free transplanting of whole skin this principle is lost. When the deeper non epithelial layers of the skin are included in the graft a much more complex process of nutrition is required. More or less necrosis is to be expected. The end result may be total sloughing or, with better success, a graft largely replaced by scar tissue and covered with an epithelium not as good as that obtained in a successful Thiersch graft.

The very heavy Thiersch grafts to which we have referred are cut about twice as thick as the ordinary Thiersch graft. They are of leathery texture, and comparable in thickness to the deep small grafts of Davis, but may be cut to large size as recently described by Blair and Brown. The area from which they are taken regenerates epithelium from the lowermost points of the papillae, from sweat glands and from hair follicles. The resulting scar is slightly less satisfactory than that of an ordinary Thiersch cutting. We employ these thick grafts to cover flexor surfaces, especially the popliteal space and other areas where trauma must be expected. A success-

ful graft of this type results in a surprisingly good quality of skin.

#### DRESSINGS

Dressings of every description have been advised for skin grafts. Since the chief factor in any case is the preparation of the surface to be grafted it is not surprising that fair success has been reported with the use of various dressings. For 2 years we have been obtaining uniformly good results with 90 to 100 per cent take in the grafts by means of a pressure dressing the essential details of which were devised by Dr W. D. Little of this clinic.

A single layer of sterile gauze moistened with salt solution is laid directly on the grafted surface in good contact with the grafts and the small areas of granulation tissue which may remain uncovered between them. On top of this are placed numerous layers of loose dry gauze sufficient to absorb any exudates which work out around the grafts. With this dressing secured the pressure dressing is applied by means of large bunches of ordinary hospital wool held firmly under a final wrapping of all cotton elastic bandage. The entire dressing is left undisturbed for 5 to 7 days.

We believe this dressing to be correct in principle. The pressure holds the grafts in firm contact throughout the period required for union,

## CHRONIC RECURRING TEMPOROMAXILLARY SUBLUXATION

SURGICAL CONSIDERATION OF "SNAPPING JAW" WITH REPORT OF A SUCCESSFUL OPERATIVE RESULT<sup>1</sup>

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THE appropriate term of "snapping jaw" has been applied to a certain group of functional derangements of the temporomaxillary joint which exhibits a peculiar susceptibility to minor disturbances of its mechanism. This disturbance of function is usually attributed to an abnormal periarticular relaxation which permits an undue mobility of the condylar head within its glenoid cavity. The simplest form of the condition is encountered with great frequency, and victims of it, although suffering no actual pain or discomfort, are nevertheless subjected to a constant annoyance as a result of the more or less conspicuous snapping noise emitted by the joint as the head of the inferior maxilla glides through its arc in response to such physiological demands as talking, yawning or the mastication of food.

Confined within these limits and manifested by such unobtrusive clinical symptoms, snapping jaw scarcely assumes the dignity of a surgical problem. Indeed in discussing surgical diseases of this joint standard surgical texts limit operative indications to such conditions as ankylosis, arthritis irreducible dislocations, and a few unusual fractures. Subluxation of the joint as a surgical consideration is either dismissed as of no importance or its existence is completely ignored.

However, ample evidence is at hand to support the contention that this minor derangement of the temporomaxillary joint may give rise to clinical manifestations which demand urgent and radical intervention. An appreciable number of cases is on record among them the one herein reported in which the commonly observed picture is complicated by attacks of acute severe joint pain by locking of the joint in various positions or by actual fixation of the inferior maxilla with the mouth in the wide open position. Relieved for the moment spontaneously or by some manipulation these attacks invariably display a disposition to recur with increasing frequency and severity, thus becoming not only a constantly menacing source of embarrassment but eventually threatening the integrity of the very highly important function delegated to this joint.

Malgaigne in 1835 collected a series of 76 cases of snapping jaw of which 54 were bilateral

and 22 unilateral, the common age incidence falling between 20 and 30 years.

Annonale reported 2 cases in 1887, both occurring in females, aged 38 and 18 years, respectively. In the first instance the patient's jaw became locked during a vomiting attack and thereafter she experienced characteristic manifestations of snapping jaw, frequently complicated by pain and fixation. The second patient found her jaw fixed in the wide open position following the act of yawning. Manual reduction corrected the condition but thereafter the patient complained of a slipping joint. Tartara saw in an infant, aged 15 months, a subluxation sustained during a convulsion and Pugh observed a similar case in a child 2 years old following a blow upon the lower jaw. Pringle suffered from the condition himself and had studied 4 other cases 2 of which were in medical students. Ashhurst operated upon a girl aged 16 years who for 2 years had complained of a painful unilateral subluxation with locking, which occurred during the act of eating or talking. During the latter portion of this period, it was necessary to keep the lower jaw bandaged owing to the fact that subluxations frequently occurred with the mouth closed. Blake describes a male patient, aged 27 years in whom the condition became so extreme that subluxation took place during sleep.

These and numerous other similar reports contributed by Perthes, Loessel, Podlaka, Schurtzel, and others indicate not only the frequency of the condition but give as well a conception of some of its clinical manifestations.

With the demonstration of such inherent potentialities, snapping jaw may, on occasion, assume a considerable degree of clinical importance and require the application of some surgical method for its relief. The appropriate measures to be employed, however are still a matter of conjecture and the limited number of cases reported to date have not conclusively proved the superiority of any particular procedure. In fact, the methods advocated are well nigh as numerous as the patients operated upon and in most instances, have been ingeniously developed without the aid of precedent, to meet the exigencies of the moment.

<sup>1</sup>Case presented before Surgical Section, New York Academy of Medicine May 7, 1906

thickness. The grafting was done in two operations the left leg on November 24, 1927, and the right 9 days later.

Grafts were cut from abdomen, thorax and back. For the entire surface the grafts showed fully 90 per cent take and there was practically complete epithelialization on December 23 when the patient was allowed to go home for Christmas vacation.

Since the legs had been maintained in complete extension there was never any tendency to contracture. For several months there was cyanosis and circulatory stasis during which time the patient walked with crutches. With the aid of massage and passive motions the difficulty was relieved and perfect function was restored at the end of 6 months. At the present time function in the extremities is normal, health is excellent and the entire surface is covered with skin of good quality (Figs. 1, 2 and 3).

CASE 2 No. 2828r Mitchell P. aged 35 years was admitted to the Robert W. Long Hospital March 29, 1929 with a callous ulcer of 4 years duration on the right popliteal space. His injury in 1925 was a gasoline burn involving the posterior aspect of the right leg. After 22 months in another hospital and repeated attempts at skin grafting he was released with an unhealed area in the popliteal space. There were three unsuccessful attempts to heal this ulcer with whole skin grafts, the last failure occurring at one of the best surgical clinics in the country. The patient was referred to us with the advice that some type of pedicled graft would be necessary. On previous occasions, however, a pedicled graft taken from the only accessible area of the other leg had failed.

Examination revealed a callous ulcer 3 inches in diameter in the right popliteal space. The ulcer was cyanotic, the epithelial covering over the posterior aspect of the leg was of poor quality and there were marked edema, cyanosis and induration. On April 1 the ulcer and the surrounding cicatrix were given extensive debridement removing dense scar tissue 2 centimeters deep so that the normal structures of the popliteal space bulged into the wound. The edges were beveled toward the periphery, the final wound being about twice the size of the original ulcer. This was dressed for 10 days with chlorazene packs and given 4 exposures to ultraviolet light in the first 4 days of that time. On April 11, 1929, there was a bed of excellent granulations upon which we placed five large thick Thiersch grafts. When the pressure dressing was removed at the end of 7 days the grafts had taken 100 per cent leaving only three narrow zones of uncovered granulation tissue. When healing was complete the leg was given massage and passive motion.

The patient was allowed to walk out of the hospital 1 month after the graft was done.

Observation on June 1, 1929, showed an excellent, pliable growth of skin, no cyanosis and only transient edema after 4 hours of walking. Complete restoration of function is to be expected.

CASE 3 No. 5904 Claude R. aged 7 years was admitted to the James Whitcomb Riley Hospital September

7, 1928 with a vicious contracture of the left leg from a burn of 6 months duration. Five days later the popliteal contracture was given complete débridement. Tenotomy of all the hamstring tendons was necessary to obtain extension of the knee. The exposed great vessels and nerves were covered with two flaps of fat and fascia and the wound was allowed to granulate. Dressings and ultraviolet light were employed according to the described technique.

A cast and later a Thomas splint were employed to maintain complete extension. On October 3, 1928, the large area of healthy granulation tissue involving the popliteal space and posterior aspect of the leg was covered with Thiersch grafts of good thickness. Removal of the pressure dressing at the end of 7 days showed 100 per cent take in the grafts.

One month later the patient was discharged walking in a cast to prevent contracture. After 6 weeks the cast was discontinued. Observation in 6 months showed complete restoration of function. There was slight keloid tendency but the scar was soft, flexible and covered with skin of good quality.

#### CONCLUSIONS

1. By the methods we have employed Thiersch grafts cut to proper thickness and successfully transplanted give a better result than do whole skin grafts.

2. The factors which render granulation tissue unsuited for grafting are cicatrix formation and infection.

3. Exposure to ultraviolet light is a valuable adjunct in the preparation of granulations. The surface must be beefy red, vascular, and free from exudates.

4. Excellent results may be obtained by dressing the grafts under pressure with dry gauze, wool and elastic bandage.

5. For the grafting of small areas which will be subjected to trauma and for flexor folds about joints we employ very thick Thiersch grafts. Joints should be splinted in full extension until all tendency to cicatrization has ceased.

#### REFERENCES

1. BLAIR, V. P. and BROWN, J. B. The use and uses of large split skin grafts of intermediate thickness. *Surg. Gynec. & Obst.* 1929, 48: 8.
2. DAVIS, JOHN STAGE. The small deep graft development relationship to the true Reverdin graft technique. *Tr. South Surg. Ass.* 1928, 21: 393.

specialization eventually exacts its penalty in terms of a mechanism more susceptible to disorganization under physiological stress and conceivably accounts for the prevalence of internal derangements in this type of joint.

The temporomaxillary articulation is classed in works on arthrology as a diarthrosis, sub division ginglymo arthrodia, signifying a mobile joint capable of executing both a hinge like and a gliding motion.

The component osseous elements of the joint are the condyle of the inferior maxilla and the glenoid or mandibular fossa of the temporal bone. The former, in cross section, is oblong with long axis transverse and it is set a bit obliquely on the neck in such a manner that its outer edge is a little more forward and a little higher than its inner one. It is acutely convex from before backward and to a lesser degree, from side to side (Fig. 1).

The squamous portion of the temporal bone provides for articulation with the head of the inferior maxilla a glenoid fossa bounded in front by the articular eminence and behind by the tympanic plate. The posterior compartment of the fossa lodges a segment of the parotid gland while the anterior or mandibular compartment presents a deep, cartilage covered concavity the radius of curvature of which in the sagittal plane corresponds very closely to the radius of convexity in the same plane of the condylar head. The cartilage coating of the articular fossa is continued forward upon the articular eminence so that this joint surface, as represented by the cartilage covered area assumes on sagittal section a concavoconvex profile (Fig. 3).

Interposed between these bony articular surfaces is the extremely interesting interarticular fibrocartilage or joint meniscus the structure and relations of which have a particular bearing on the subject in hand.

This meniscus is a thin fibrous plate of oval form thicker at its circumference, especially behind, thin at its center where indeed, a normal perforation is occasionally found. It is closely and intimately applied to the condylar head and so maintained in part by its circumferential attachment to the capsular ligament but more by its relation to the fibers of the external pterygoid muscle which gain an insertion to the neck of the condyle in front and to the corresponding anterior margin of the meniscus as well (Figs. 1 and 3).

A capsular ligament envelops the joint in a thin loose capsule passing from the margins of the glenoid cavity and the articular eminence immediately in front to the upper margin of the interarticular fibrocartilage and from the lower



Fig. 3 Vertical section of temporomaxillary articulation to show relations of the condyle meniscus synovial cavity, pterygoid muscle and glenoid fossa. (After Gray.)

margin of this cartilage to the neck of the condyle which it completely invests (Fig. 4).

The joint cavity is thus divided by the interarticular fibrocartilage into two separate and unequal compartments. Both of these compartments are provided with distinct synovial sacs, the upper one of which is much larger and more extensive, and its lining membrane is continued from the margin of the cartilage covering the glenoid cavity and articular eminence and reflected onto the upper surface of the fibrocartilage. The lower and smaller passes from the undersurface of the cartilage to the neck of the condyle (Fig. 3).

This delicate structure is supplemented by three important ligaments designed to stabilize the articulation and confine the mobile condylar head within normal limits. Of these, the external lateral ligament is attached to the outer surface of the zygoma in front of the joint whence it is directed obliquely downward and backward to secure attachment to the outer and posterior border of the neck just below and behind the head (Fig. 4). It quite obviously is designed as a check ligament to limit the posterior excursion of the head and thus tends, not only to prevent posterior dislocations, but endeavors as well to protect the neighboring middle ear.

The stylomandibular ligament extends downward and forward from the tip of the styloid process to the posterior border of the angle of the jaw (Fig. 5) and gains attachment to a point distal to the axis of rotation of the bone. Its mechanical advantage is consequently exerted (1) to check extreme anterior rotation of the jaw and (2) thus indirectly and simultaneously to limit the posterior excursion of the head. The internal lateral ligament, of lesser importance, is so disposed as to stabilize lateral mobility of the inferior maxilla but it, too, by reason of its insertion



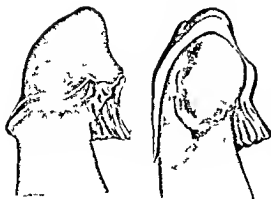


Fig. 1 (left) Lateral view of the condyle of the mandible capped by the articular disc showing sinuous outline of latter and its attachment to the external pterygoid muscle (After Pringle)

Fig. 2 Sagittal section of the articular disc one half of which has been removed to show the central and anterior ridges with depression between them. The attachment of the external pterygoid muscle also is shown (After Pringle)

It is the intent of the present report to add to the existing meager knowledge of the subject merely another experience which may perhaps contribute a better conception of temporomaxillary subluxation and possibly lead to the development of standardized methods for its treatment.

Concerning the nature of this lesion the conclusion naturally first suggests itself that the disturbances observed are dependent solely upon simple complete recurring dislocations of the condyle of the inferior maxilla differing only in degree from the common traumatic dislocations, with which it was therefore classified for a considerable period of time.

In 1827 however Sir Astley Cooper directed attention for the first time to the possibility that relations intermediary between normal and complete dislocation might exist between the condyle and its glenoid cavity, i. e., incomplete luxation or, as he termed it, subluxation.

According to his conception subluxation of this particular articulation involved the separation of the interarticular fibrocartilage or meniscus from the condyle to which it is normally firmly attached, followed by the riding forward of the condyle, without its meniscus, onto the articular eminence. In short, the process was essentially an intrinsic internal derangement of the articulation quite distinct etiologically and pathologically from the result of external trauma as seen in the simple complete dis-

locations. As a result of Cooper's experience with 4 cases, he came to the conclusion that the disease was practically confined to the female sex in which general depletion and lowered resistance by determining an abnormal relaxation of the joint ligaments, became the actual inciting factors in this type of interarticular disorganization.

Even though the results of subsequent investigation seem to call into question this interpretation of the mechanism productive of snapping jaw, Cooper's observation derives its real importance from the fact that it established the identity of subluxation of the temporomaxillary joint in particular and directed attention to the significance of internal joint derangements in general.

This variety of dysfunction is, of course not confined to the temporomaxillary joint for its prototype is not uncommonly observed in such joints as the shoulder hip and knee—in other words, in those articulations the functional demands of which have developed the need for specialization in structure.

It is pertinent at this point to recall certain biological principles which have a practical bearing upon this subject. In general it may be stated that the survival of a species is dependent upon the integrity and efficiency of certain physiological processes which are vital to the individual of the species. Nature's methods of safeguarding and rendering more effective such vital functions are well demonstrated in race history as developmental specialization. Specialized functions require specialization in structure proportionate to the importance of the function concerned.

As applied particularly to articulations, we find that those joints the function of which has to do with locomotion, defense, the acquisition of food and its preparation for assimilation express these principles in terms of the highest mechanical development. The equipment of the knee, hip, shoulder, and temporomaxillary joints exemplifies in varying degrees an architecture designed to give the utmost in efficiency and mobility without sacrifice of stability, an ideal which is attained by an elaborate development of synovial membranes, articular cartilages and ligaments. Of these the temporomaxillary is unquestionably the most highly specialized intricate, and efficient and may perhaps for this reason be regarded as the most important from a biological viewpoint.

At the same time the increasing structural complexity which goes hand in hand with higher

separation of the meniscus from the condylar head followed by the riding forward of the latter, minus this meniscus, upon the articular eminence. Thus according to this theory, the gross pathology involved the separation of the meniscus from the head of the bone. Pringle, however, in discussing this point, recalls the fact that, although the generously proportioned superior joint compartment permits free movement in the horizontal plane between cartilage and the surface of the glenoid, the limited lower compartment permits only restricted rotary motion between the cartilage and head of bone. Therefore while it may be dragged freely in all directions over the condylar head, the cartilage is intimately attached thereto at its periphery and accordingly must accompany the condyle in any position assumed by it. For this reason, complete dislocation of the cartilage alone does not take place and explanation of the phenomena of subluxation on this basis consequently becomes unacceptable.

In offering an alternative explanation Pringle directs attention to certain significant features in the structure and relations of the cartilage. He refers to the fact that the cartilage as applied to the dome like head of the condyle presents in the coronal plane and extending over the summit of the dome a thickened ridge in front of which there is a corresponding depression. Hence, as seen from its lateral aspect it assumes a concavoconvex surface which fits accurately the reciprocal irregularities of the glenoid fossa. Furthermore, it will be recalled that the powerful internal pterygoid muscle gains an attachment to the antero internal aspect of the cartilage thus tending to exert at this point in the loosely applied structure a potential pull the direction of which is forward and inward (Fig. 2).

Utilizing these facts Pringle suggests the theory that under certain conditions e.g. a sneeze with the mouth in the wide open position a sudden violent contraction of the internal pterygoid muscle may act to displace the loosely applied cartilage so that the thick central ridge lies obliquely instead of transversely. The cartilage then assumes the rôle of a foreign body caught between the rolling condyle and the glenoid surface. The disc is crushed between the opposing bony surfaces and painful locking of the joint is prone to follow. These events produce stretching of the periarticular tissues promoting recurrence of the same phenomena and giving rise to the annoying snapping noise characteristic of the condition.

This theory is a satisfactory explanation of the causation of the symptoms noted in snapping jaw

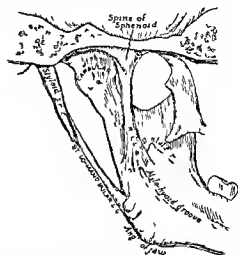


Fig. 5 Internal aspect of temporomandibular articulation to show internal lateral capsular and stylomandibular ligaments (After Gray)

and is founded upon actually demonstrable mechanical and anatomical conditions. It is most probable that the majority of clinical examples of this lesion owe at least their inception to some variation of the train of events described.

Nevertheless it is evident that whatever may be the mechanisms initially concerned, the sum total of their operation is periarticular relaxation and that several other factors also may enter into the production of this latter condition. The following case may be cited as illustrative of this point.

**CASE 1.** A robust male aged 23 years was first seen February 1, 1926 in consultation with his physician. In 1920 he had sustained an injury to his lower jaw which was said to have resulted in a fracture dislocation. Upon removal of the retentive dressing applied in treatment of this condition he observed that the left temporomandibular joint exhibited an unwanted degree of mobility. As time went on this mobility became gradually more pronounced and every active motion of the lower jaw became associated with a loud snapping noise referred to this joint. Recently the right articulation began to display similar disturbance but to a lesser degree.

Eventually the noise emitted by the left joint became so prominent and constant as to intrude itself annoyingly into the conversation whenever the patient opened his mouth to articulate. So seriously did this state of affairs interfere with his occupation as an insurance salesman that some relief from the embarrassing situation became imperative.

Examination of the affected joint gave but little information. There was no tenderness to pressure and no deformity could be detected. The condylar head upon the left seemed a little more prominent and the excursion of the head seemed slightly greater than upon the right. Passive motion of the lower jaw with muscles relaxed disclosed very definitely an abnormal laxity in both joints but was particularly marked upon the left. When active motion of the lower jaw took place as in opening the mouth a loud snapping noise was

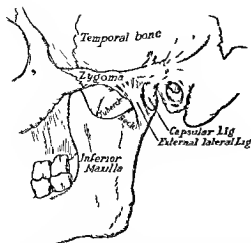


Fig 4 External aspect of temporomandibular articulation to show external lateral and capsular ligaments (After Gray)

in proximity to the axis of rotation of this bone, undoubtedly is a supporting factor in the movement

It is therefore apparent that the mechanical disposition of the extrinsic ligaments, together with the posterior thickening of the capsular ligament which is strongest in this region represent elaborate precautions against the possibility of posterior displacement of the condyle. It is equally apparent that no analogous structure is provided to restrict the degree of posterior rotation of the angle of the inferior maxilla and in consequence the excursion of the condyle forward in proximity to the thinnest and weakest portion of the capsular ligament. These structural peculiarities unquestionably bear a causal relation to the prevalent forward luxation of this joint.

This anatomically complex structure is capable of translating itself into a versatility of movement which is seen in no other joint and which resolves itself into three chief and distinct types: (1) a hinge like motion about a transverse horizontal axis drawn tangentially to the upper articular surfaces of the condylar heads and taking place entirely in the inferior synovial cavity; (2) an anteroposterior gliding movement along a horizontal plane, taking place entirely in the roomy upper compartment between the upper surface of the meniscus and the glenoid cavity; and (3) an oblique rotatory movement made up of two components: (a) a rotatory movement about a vertical axis through each condylar head confined to the lower synovial compartment; and (b) an oblique gliding movement confined to the

upper compartment, the meniscus gliding forward and inward on one side as it moves backward and inward on the other.

Normal mastication of food, incident to its preparation for the first step of physiological digestion, calls into play all the resources of this mechanism. As the mouth is opened in anticipation of the reception of food, the point of the jaw is depressed the angle begins to rotate posteriorly while the condyle and major portion of the ascending ramus move forward. The fixed point or axis of rotation of the inferior maxilla as a whole is represented by a horizontal line drawn through the two dental foramina.

In effect the mechanics of this movement suggest a close analogy with those of a lever of which the axis of rotation or fixed point corresponds to the fulcrum, the ascending ramus from the dental foramina to the joint surface corresponds to the short arm while the horizontal ramus inclusive of the angle, may be likened to the long arm. Depression of the point of the jaw, the long arm of the lever is at the outset compensated at the joint—the apex of the short arm—by a hinge like motion confined to the lower synovial compartment. But as the movement of the long arm carries through the end of the short arm, obeying the principle of levers, is called upon to travel through an arc proportionate to that described by the end of the long arm. At this point, since the hinge motion of the lower compartment is no longer adequate the upper compartment comes into action permitting the condyle with its meniscus to glide forward upon the summit of the cartilage-covered articular eminence. Normally the condyle never passes this summit for should it do so, it slips over with its meniscus, into the zygomatic fossa to become a true dislocation. Nevertheless it is to be noted that the margin of safety here is a very narrow one since there are no evident safeguards such as those observed posteriorly, to interpose a check upon excessive movement and possible dislocation.

As the inferior maxilla returns to its original position in the shutting movement of the jaw, the condyle glides back with its meniscus in the reverse direction utilizing the combination of the gliding hinge and rotary motions to give the cutting and tearing power to the incisor teeth.

These structural and functional details relating to the temporomandibular joint are worthy of consideration in seeking to establish the true nature and etiology of its subluxation.

Cooper believed as noted above, that the causative factors in this condition comprised the

in his case of snapping jaw the classical triangular incision, while Blake resorted to a transverse incision along the zygoma only to find that he was unable to carry out the procedure planned through such exposure.

In the case herein reported I found the vertical skin incision to be quite suitable for purposes of joint exploration and believe that, at least from a cosmetic viewpoint, it possesses considerable advantage.

This incision is carried down to the deep fascia and here an expedient based upon the local anatomy may be utilized to safeguard the temporofacial nerve. Dissections of this region demonstrate that this nerve remains deep to the deep or external parotid fascia until it reaches a point well above the level of the zygoma, where it is seen to pierce this fascia to continue its course superficially (Fig. 6). It will be recalled also that the deep fascia of this region splits below into two layers to enclose the parotid in its fascial capsule, the external and internal leaves of which again unite at the zygoma to become continuous with the temporal fascia.

Keeping in mind these anatomical facts the operator may widely retract the vertical skin incision and transversely incise the external leaf of the parotid fascia for a distance of 2 inches parallel to and just below the zygoma. The nerve, since it is deep to the fascia at this point, is safe from injury and the gland, thus freed, may be retracted downward and forward carrying the nerve with it out of the field of operation (Fig. 6).

The actual method of treatment to be applied to the articulation itself in attempting correction of the symptoms of subluxation must necessarily depend upon the gross pathology encountered. Etiological considerations suggest that operative effort must be directed (1) to the meniscus itself which may call for fixation or removal and (2) to the unduly mobile condylar head and the abnormally relaxed capsule, the former requiring limitation of its excursion and the latter demanding some expedient to overcome periarticular laxity. I was fortunate in meeting conditions which responded to simple plication of the capsule. It is improbable however, that such favorable conditions frequently exist and it appears evident from the large number and wide diversity of methods proposed that none has been universally satisfactory.

The following classification of methods operative and non-operative which have been suggested for treatment of subluxation of the inferior maxilla, has been compiled from the liter-

ature and gives some conception of the scope of efforts in this direction.

## I Non-operative methods

### A Dental technical procedures

#### 1 Outside mouth

- a Apparatus, fastened around chin and held in position by cap on head limits chewing motion and depression of point of jaw

#### 2 Inside mouth

- a Splint, fastened to upper and lower jaw with interlocking catch hinge, is adjustable to limit motion of lower jaw (Schroeder)
- b Hard rubber plate fixed to upper jaw and provided with process pointing to edge of masseter muscle or coronoid process limits excursion of latter (Fritzsche)

### B Injection of corrosive fluids into joint (to produce shrinkage of capsule and promote adhesions)

- 1 Tincture of iodine (1/2 cubic centimeter tincture of iodine injected into joint posteriorly secured permanent cure in case of girl aged 20 years reported by Perthes)

#### 2 Alcohol

## II Operative method

### A Treatment of capsule

- 1 Excision of portion of capsule is followed by suture to overcome redundancy (Perthes)
- 2 Simple plication of capsule after exploration of joint takes up redundancy and tightens joint

### B Utilizing fascial strip (turned down from temporal region to check excursion of head as described by Nieden)

### C Treatment of meniscus

- 1 Fixation of disc by suture to periosteum of mandibular fossa (Haeber)
- Fixation of disc in vertical position in front of condylar process (Konjetzny)
- 3 Removal of the articular disc (Ashhurst)

Of the non-operative methods, those depending for their effectiveness upon the employment of some mechanical apparatus whether external or internal to limit the excursion of the lower jaw are open to serious objection. Externally applied mechanisms of the type described above are obviously impracticable, while those splints devised for internal use give rise to pressure ulcers, periostitis, general discomfort, and pain.

Nieden remarks that resort to methods of this sort indicates either that operative measures must be quite ineffective or that they are too little known, the latter explanation being in his opinion the acceptable one. Perthes however reports a permanent cure in the case of a girl, aged 16 years, treated 6 months by means of a hard rubber splint of the Fritzsche type.

The injection of corrosive fluids into the joint to secure shrinkage of the capsule and to promote adhesions has some basis in reason and Perthes reports a case in which a cure was obtained by injecting tincture of iodine into the joint capsule posteriorly. Thus raises the interesting question as to how much the factor of irritation contributes

audible throughout the room as the head of the bone rode over its articular surface. All motions were carried out without pain and there was no limitation to any normal movement.

X-ray examination demonstrated normal joint outlines. With the mouth wide open the left condylar head rode forward farther on the articular eminence than did the right but no true dislocation could be shown.

Although he was advised that surgical measures offered a very dubious prognosis for cure of this condition the patient was insistent that some attempt at operative relief be undertaken.

Operation was performed on February 1926 at the Post Graduate Hospital. General anesthesia was used. A vertical incision 2 inches in length with its upper extremity overlying the roof of the zygoma was made just in front of the auricle. The incision was carried down to the deep fascia and the auriculotemporal nerve and superficial temporal vessels were retracted posteriorly. A transverse incision was made along the inferior margin of the zygoma and carried forward through the deep or external parotid fascia. The parotid gland now could be retracted downward and forward carrying with it the temporofacial branch of the facial nerve. The joint itself was easily exposed without danger of injury to important neighboring structures. The capsule was found to be extremely relaxed and loose permitting an unusual degree of mobility to the condylar head within its glenoid cavity. The capsule was incised vertically to expose the interior of the joint which could be readily explored due to the laxity of its capsule. The joint meniscus could not be found and the articular surface of the condyle was roughened and eburnated. For the purpose of limiting the mobility of the condylar head its articular surface was scarified and after closing the capsule a series of reefing stitches of chromic gut were inserted. The wound was closed without drainage and the lower jaw immobilized by means of a bandage.

The incision healed uneventfully. On the seventh day after operation the bandage was loosened to permit some motion of the jaw. On the tenth day the retentive dressing was completely removed and ordinary motion was encouraged. At the end of the second week all functions could be carried out without pain. The joint was perfectly stable. Abnormal mobility appeared to be corrected and the annoying snapping noise had completely disappeared. When last seen 3 years after operation the patient had no complaints and was well pleased with the results obtained.

Peri articular relaxation appears to have been the etiological factor in the symptoms described in this case. Relief of the symptoms was accomplished by joint scarification and plication of the lax capsule. It is probable that the peri articular relaxation was directly attributable to the loss of the stabilizing action of the joint meniscus whose absence may in turn be traceable to the effects of trauma sustained when the jaw was fractured 6 years previous to the onset of the snapping jaw. It may be surmised that such an injury could have produced fracture or crushing injury of the meniscus sufficient to determine its atrophy and complete dissolution.

Concerning technical details, it is worthy of note that this joint although superficially placed is surprisingly inaccessible for satisfactory surgical approach and its adequate exposure presents

somewhat of a problem. On the one hand, cosmetic demands limit the incision as to length and location, on the other certain restrictions are imposed by the proximity of important structures requiring protection. Among the latter may be mentioned the facial nerve (temporofacial branches), superficial temporal vessels, auriculotemporal nerve and internal maxillary artery.

The facial nerve, after leaving the stylomastoid foramen, passes downward outward, and forward through the substance of the parotid gland to divide, just posterior to the ascending ramus of the inferior maxilla, into two main terminal groups the temporofacial and the cervicofacial. The former running forward and upward in front of the external auditory meatus passes close to the joint on its antero inferior aspect (Fig. 6). A line drawn on the surface from the tip of the mastoid to the outer canthus of the eye represents roughly the highest branch of this group of nerves. Close to and in front of the external auditory meatus the superficial temporal vessels and the auriculotemporal nerve in their vertical course to the temporal region pass just posterior to the articulation although on a more superficial plane.

Thus as pointed out by Henderson and New the articulation occupies roughly the center of a triangular area base upward, bounded by the temporal vessels behind and the temporofacial nerves in front. This triangular area is therefore devoid of superficial structures of importance and through it the joint may be safely exposed.

The internal maxillary artery is deeply placed, passing close to the inner side of the neck of the inferior maxilla, and is therefore not liable to injury during simple arthrotomy procedures.

The conventional incision described for exposure of the joint has been planned with radical excision in mind. Murphy, Lihenthal, Henderson and New and Annondate employed incisions which, save for unimportant modifications are identical in principle, i. e., each is a curved hook shaped or right angled incision with one limb parallel to the zygoma and the other carried downward in front of the pinna to secure a triangular flap. Burdick for purposes of joint resection has modified this incision by the addition of a posterior limb carried back over the ear and is of the opinion that the sacrifice of the temporal vessels thus entailed is more than compensated by the increased effectiveness of the exposure so obtained.

In operations limited to arthrotomy however a simple vertical incision in front of the pinna has usually proved to be quite adequate for the purpose in hand. Nevertheless Ashhurst utilized

treatment of both capsular and meniscus derangements if satisfactory results are to be obtained.

It is worthy of note that modern joint surgery in general, under the influence of accumulating experience and perfected technical detail, has shown a tendency to widen its scope of operability. Operative indications, which were formerly limited to the more grave pathological conditions, have been gradually extended to include a variety of derangements the minor character of which did not justify the hazards imposed by the older methods. The acceptance of the minor joint lesions for radical surgical treatment indicates the highest degree of confidence in the safety and efficiency of the methods employed and offers as well the most convincing evidence of the advances made in this field.

The temporomaxillary joint, however, has been slow to profit by this development and there still exists a very evident reluctance to apply to this joint the principles which have proved their safety and effectiveness in analogous minor lesions of the knee, hip and shoulder.

Glancing over the list of measures proposed for treatment of temporomaxillary subluxation, one is impressed by the number of methods and the diversity of principle represented. Under ordinary circumstances such a state of affairs spells the complete failure of all suggested methods to solve satisfactorily the problems presented and this interpretation may not be unjustified in this instance. Nevertheless, it appears to the writer that the true explanation must be sought in the failure to recognize the pathological physiology of this condition. If the choice of treatment be predicated upon a study of the normal mechanics of the joint and of the factors underlying subluxation the selection of the method will be limited to those few operations emphasized above which are competent to cope with the physical principles involved. Wider usage of these methods will prove their practical utility and will demonstrate that numerous cases of temporomaxillary subluxation which have been habitually rejected may be accepted for treatment with every assurance of a satisfactory result.

#### SUMMARY

In conclusion, therefore the present status of temporomaxillary subluxation may be summarized as follows:

1. Temporomaxillary subluxation is a definitely distinct entity the pathological condition of which is characterized by a distortion of the normal relations of the joint meniscus leading to

capsular relaxation. Resulting disturbances in joint mechanics are responsible for a variety of joint dysfunction best known as snapping jaw.

2. Commonly seen as a painless, noisily functioning joint the efficiency of which is not at all impaired, it is occasionally encountered in the form of chronically recurring attacks of pain and locking requiring immediate treatment.

3. There exists an unexplained reluctance to apply to this joint the radical operative measures which have become the accepted treatment for analogous minor lesions of other joints.

4. Failure to take into consideration the pathological physiology of temporomaxillary subluxation has been responsible for a large number of proposed methods of treatment representing a wide divergence of principles.

5. Two methods of treatment are emphasized which are based upon sound surgical principles and upon a study of the mechanics of the joint.

6. Utilization of these methods should stand ardent treatment and demonstrate the practicability of accepting a larger group of these cases for radical operation.

#### BIBLIOGRAPHY

1. ANKORDE, THOMAS. Displacement of the interarticular cartilage of the lower jaw and its treatment by operation. *Lancet* 1887: 411.
2. ASHURST, A. P. C. *Ann Surg* 1921 lxviii 712.
3. BLAKE, J. B. Recurrent dislocation of the lower jaw. *Tr Am Surg Ass* 1918 xxvii 350.
4. BURDICK, CARL G. Personal communication.
5. COOPER, H. *Treatise on Dislocations*. London: R. B. Cooper 184: p. 393.
6. HENDERSON, M. S. and NEW, G. B. Ankylosis of the jaw. *Surg Gynec & Obst* 1918 xxvii 451.
7. KONJETZKY, G. E. Habitual dislocation of the lower jaw. *Arch f klin Chir* 1921 cxvii 631.
8. LILIENTHAL, H. Bilateral temporomaxillary ankylosis. *Ann Surg* 1911 liv 145.
9. LOESSL, J. Niden's operation for habitual dislocation of the mandible. *Zentralbl f Chir* 1926 lxx 1749.
10. MALOUGIN, F. J. *Traité des fractures et luxations*. Paris: Baillière Tindall & Co 1855: p. 288.
11. MCKENRY, J. B. *J Am M Ass* 1914 lxi January.
12. NIDEN, H. Ueber Operative Behandlung habitueller Kieferluxationen. *Deutsche Zschr f Chir* 1923 clxxviii 358.
13. PERRIES, G. Die Verletzungen und Krankheiten der Kiefer. *Deutsche Chir* 1907 xxviii 40.
14. PODLASKA, J. *Zentralbl f Chir*, 1926 lxx 2199.
15. PRINGLE, J. H. Displacement of the mandibular meniscus and its treatment. *Brit J Surg* 1919 vi 385.
16. PUGHE, *Lancet* 1853: 14.
17. SCHNITZLER, J. Zur Frage nach der Existenz eines Kapselrisses bei der Kieferluxation. *Zentralbl f Chir* 1901 p. 890.
18. TARTAGLIA, Journal de Leroux, Boyer and Crousant xl p. 182.

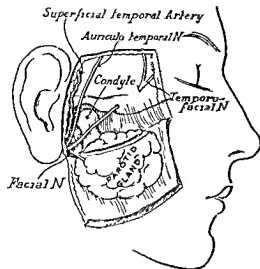


Fig 6 Schematic drawing from dissection of parotid region. Horizontal incision has been made along lower border of zygoma through the external leaf of the parotid fascia. The parotid is then turned downward and inward after the temporo-facial has been dissected free (note groove) in order to permit latter to assume normal relation to the neck of condyle. Note temporo-facial nerve piercing fascia above condyle.



Fig 7 Showing plan of Nieden's operation. Flap of the temporal fascia turned down and sewed to capsule of joint (After Nieden)

to produce cure in joints subjected to the trauma of such operations as capsule plication.

Of the operative methods the procedure of Nieden is based upon the soundest surgical principles. In this operation the joint capsule is exposed through a vertical incision which is then extended upward and backward thus exposing the temporal fascia. A strip of this fascia with base above the zygoma is turned downward in such a manner as to permit suture of the free end into the joint capsule thus limiting the excursion of the condylar head (Fig 7).

Nieden employed this operation successfully in the treatment of a case of bilateral subluxation and was able to demonstrate after operation the functioning of the cheek ligaments whose pull could be plainly felt beneath the skin as the condylar head moved forward during the act of rotation of the inferior maxilla.

This operation and that of simple plication of the joint capsule undoubtedly offer the most effective means available for correction of subluxations dependent upon capsular relaxation and are therefore the methods of choice in these cases. Some writers believe however, that capsular relaxation represents a secondary manifestation of pathology residing in the meniscus and consider that, to be adequate, treatment must be directed at the primary condition.

Haber fixed the disc by suture to the periosteum of the acetabulum and Konjetzny resorted to a more elaborate procedure to fix the disc forward on the condyle. After exposing the joint, he separated the disc from its anterior relations with the capsular wall, the lateral and medial relations being carefully preserved. Some of the upper fibers of the external pterygoid muscle are separated from the condyle and the disc is then displaced forward on the articular head of the bone until it is in a vertical position where it is fixed by sutures. Ashhurst has gone to the extreme of completely removing the disc and reports good results therefrom.

The rationale of fixing the meniscus to the periosteum of its acetabulum is apparent in view of what has gone before and it is equally apparent that operative displacement or actual removal of the cartilage is not free from harmful results. Knowing that this structure equalizes the movements of the condyle and serves by virtue of its elasticity as a buffer between the articular surfaces of the joint its deliberate forward displacement seems scarcely justifiable under ordinary circumstances. Concerning its actual removal, it may be pointed out that in the case here reported absence of the cartilage seems to have been the factor leading to capsular relaxation and subsequently to subluxation.

In the final analysis it must be said that every case of subluxation must be a rule unto itself and it is probable that the majority of instances will present pathological conditions which will require

treatment of both capsular and meniscus derangements if satisfactory results are to be obtained.

It is worthy of note that modern joint surgery in general, under the influence of accumulating experience and perfected technical detail, has shown a tendency to widen its scope of operability. Operative indications, which were formerly limited to the more grave pathological conditions, have been gradually extended to include a variety of derangements the minor character of which did not justify the hazards imposed by the older methods. The acceptance of the minor joint lesions for radical surgical treatment indicates the highest degree of confidence in the safety and efficiency of the methods employed and offers as well the most convincing evidence of the advances made in this field.

The temporomaxillary joint, however, has been slow to profit by this development, and there still exists a very evident reluctance to apply to this joint the principles which have proved their safety and effectiveness in analogous minor lesions of the knee, hip and shoulder.

Glancing over the list of measures proposed for treatment of temporomaxillary subluxation, one is impressed by the number of methods and the diversity of principle represented. Under ordinary circumstances such a state of affairs spells the complete failure of all suggested methods to solve satisfactorily the problems presented and this interpretation may not be unjustified in this instance. Nevertheless, it appears to the writer that the true explanation must be sought in the failure to recognize the pathological physiology of this condition. If the choice of treatment be predicated upon a study of the normal mechanics of the joint and of the factors underlying subluxation, the selection of the method will be limited to those few operations emphasized above which are competent to cope with the physical principles involved. Wider usage of these methods will prove their practical utility and will demonstrate that numerous cases of temporomaxillary subluxation which have been habitually rejected may be accepted for treatment with every assurance of a satisfactory result.

#### SUMMARY

In conclusion, therefore, the present status of temporomaxillary subluxation may be summarized as follows:

1. Temporomaxillary subluxation is a definitely distinct entity the pathological condition of which is characterized by a distortion of the normal relations of the joint meniscus leading to

capsular relaxation. Resulting disturbances in joint mechanics are responsible for a variety of joint dysfunction best known as snapping jaw.

2. Commonly seen as a painless, noisily functioning joint the efficiency of which is not at all impaired, it is occasionally encountered in the form of chronically recurring attacks of pain and locking requiring immediate treatment.

3. There exists an unexplained reluctance to apply to this joint the radical operative measures which have become the accepted treatment for analogous minor lesions of other joints.

4. Failure to take into consideration the pathological physiology of temporomaxillary subluxation has been responsible for a large number of proposed methods of treatment representing a wide divergence of principles.

5. Two methods of treatment are emphasized which are based upon sound surgical principles and upon a study of the mechanics of the joint.

6. Utilization of these methods should standardize treatment and demonstrate the practicability of accepting a larger group of these cases for radical operation.

#### BIBLIOGRAPHY

1. ANONDALE THOMAS. Displacement of the interarticular cartilage of the lower jaw and its treatment by operation. *Lancet* 1837 i 411.
2. ASHURST A P C. *Ann Surg*, 1922 LXIII 712.
3. BLAKE J B. Recurrent dislocation of the lower jaw. *Tr Am Surg Ass* 1918 XXXVI 350.
4. BURDICK CARL G. Personal communication.
5. COOPER H. *Treatise on Dislocations*. London B B Cowper 184 p 393.
6. HENDERSON M S and NEW G B. Ankylosis of the jaw. *Surg Gynec & Obst* 1918 XXVII 451.
7. KONJETZKY G E. Habitual dislocation of the lower jaw. *Arch f klin Chir* 1921 CXVI 681.
8. LILIENTHAL H. Bilateral temporomaxillary ankylosis. *Ann Surg* 1911 LIV 145.
9. LOESSL J. Nieten's operation for habitual dislocation of the mandible. *Zentralbl f Chir*, 1926 LIII 1749.
10. MALGOUYRE F J. *Traite des fractures et luxations*. Paris: Baillière Tindall & Cox 1835 p 288.
11. MURPHY J B. *J Am M Ass* 1914 LIII January.
12. NIEDEN H. Ueber Operative Behandlung habitueller Kieferluxationen. *Deutsche Zschr f Chir* 1923 CLXXIII 358.
13. PERTHES G. Die Vertelungen und Krankheiten der Kiefer. *Deutsche Chir* 1907 XXVIII 40.
14. PODLASKA J. *Zentralbl f Chir* 1926 LIII 2199.
15. PRINGLE J H. Displacement of the mandibular meniscus and its treatment. *Brit J Surg* 1919 VI 335.
16. PUGH. *Lancet* 1833 i 14.
17. SCHNITZLER J. Zur Frage nach der Existenz eines Kapselrisses bei der Kieferluxation. *Zentralbl f Chir* 1901 p 889.
18. Tartara. *Journal de Leroux*. Boyer and Croissant XI p 182.



## POST-RADIATION PREGNANCY

## REPORT OF A CASE

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SO much confusion and controversy exist regarding the effect of X rays on the female and her offspring that many physicians are prone either to withhold the therapeutic use of the X ray, or to use it only as a last resort in hopelessly diseased conditions. It is well known that the X rays have proved beneficial in the treatment of pathological gynecological conditions where a repressive action is desired, and its use in such cases is considered proper procedure. But in the treatment of functional female disorders, especially where subsequent pregnancies are desired, such use has not as yet met with universal approval. The occasional unfortunate malformation of offspring born of irradiated mothers has been heralded as a positive contra indication for its use in the case of women with childbearing possibilities. An attempt has been made to apply the conclusions of radiation's ill effects on lower animals to humans but as yet no proof has been authenticated justifying such interpretations of these phenomena, nor are we sure that the response of tissues of the different species to identical irradiation is the same.

As proof of the evil effects of radiation Murphy cites his study of statistics of malformed offspring of irradiated mothers, and there are indeed many instances (16) reported in the literature of the birth of abnormal children following irradiation of the mother. In all these cases however, radiation was given during the course of pregnancy, and we may explain these occurrences from our knowledge that as radiation is most effective in destroying embryonic tissue the fetus is the first to suffer. That a radiated fetus is usually impaired *in utero* has been shown by Ries Zappert, and James, although Kane reports a normal child following radium therapy during pregnancy. In its employment for the treatment of functional disturbances of the ovary and for sterility however we attempt to limit the radiation action primarily to the ovaries and that normal children may be born following such radiation of the ovary has been reported by Rubin, Rongy Martius Doederlein, the present writer, and others. Whether or not an ovary so irradiated as to suppress the menstrual phenom-

ena for a more or less extended period of time can recover so as to produce again healthy ova which are capable of fertilization and development into normal children is not so definitely proved, yet such occurrences as have been reported especially by Doederlein and Schmitt, would seem, however to bear out this assumption.

In connection with this question, one must consider the permanency of such suppression of ovarian function. Not all the factors which limit our ability to suppress ovarian function by X rays are determined. Beclere suggests that there is an age limit to permanency of roentgen castration. Stern, in his work on irradiation of fibroids, noted the difficulty in producing amenorrhoea in young women. Penzoldt is of the opinion that the injury to the ovum may continue up to 4 months after irradiation of the ovary and therefore impregnation within that time may lead to the formation of an imperfect fetus but ova occurring with later menstruation may be normal and allow for natural impregnation and subsequent normal fetal development.

Titus has reported normal pregnancy in the case of carcinoma of the cervix treated by radiation. In 1923 I reported a case of twin pregnancy occurring after a temporary amenorrhoea of 7 months, removed by operative procedure and as far as histological examination could show the developing embryos were evidently normal before operation.

It is well known that pregnancy tends to debilitate patients suffering from acute tuberculosis especially where frequent pulmonary hemorrhage occurs. For this reason in such conditions abortion is usually advised. Until now surgical emptying of the uterus has been the method employed but following upon the report of the successful work done by Weyer and Mayer in therapeutic abortion by X ray irradiation this latter method has been suggested by our service at Bellevue Hospital, for the handling of such cases.

In the case reported herewith there existed a severe acute pulmonary tuberculosis with recurrent hemorrhages.

M. F. married and 30 years entered the hospital, February 1927 complaining of pains in chest and hem-

orrhages from the mouth. She was 35½ months pregnant. She has one living child 8 years old and has had three miscarriages. On account of her pulmonary condition she was advised to have her pregnancy terminated. She received roentgen ray treatment over the pelvis. The dosage was 75 per cent anteriorly and 50 per cent posteriorly. A skin erythema dose was delivered by high voltage heavily filtered X rays over a period of 14 days. Spontaneous abortion failing to occur in 6 weeks the uterus was surgically emptied through simple vaginal hysterotomy on April 11, 1927. Following her operation she did not again menstruate and did not return to the clinic. When she did return on April 6, 1928 there were evident signs of pregnancy in our opinion of 2 to 3 months. The question then arose as to the advisability of permitting her to carry on. Inasmuch as the temporary amenorrhoea had benefited her general condition and no pulmonary hemorrhages had occurred during that time it was decided to let her proceed with the pregnancy, provided that by reason of the previous irradiation the fetus was not damaged and would develop normally. We felt reasonably sure no damage had occurred to the fetus and she so assured the mother. She proceeded normally with the pregnancy and on October 27, 1928 gave birth to a perfectly normal male child weighing 7½ pounds. There was no difficulty in the delivery. Today 24 months following birth the child is hale and hearty and is altogether normal in development.

#### CONCLUSIONS

Permanent amenorrhoea in young women is not certain to be produced with X rays.

Not all ova may be destroyed by the X ray castration in young women and any such ova not destroyed may normally ripen, become impregnated, and develop into a normal healthy child.

Abnormality in a child so born has not been noted.

#### BIBLIOGRAPHY

1. Hagg II J. *Am J Roentgenol* 1926, vol xvi.
2. BÉCLÈRE A. *J de radiol et d'Electrol* 1925 ix.



FIG. 1. Post radiation baby at 11 months of age. The child is perfectly normal, active, in excellent health and has 8 teeth.

3. DOEDERLEIN A. *Deutsche med Wchnschr* 1918 No 54.
4. KANE H F. *Virginia M Month* 1926 August.
5. KAPLAN IRA I. *Am J Obst & Gynec*, 1927, vol xiv.
6. Idem. *Am J Obst & Gynec* 1928 vol xv.
7. MARTIUS H. *Zentralbl f Gynaek* 1927, January.
8. MURPHY D P. *Surg, Gynec & Obst* 1928 xliii, 01.
9. PENZOLDT R. *Strahlentherapie* 1926 vol xxi.
10. RIES L. *Am J Obst & Gynec* 1926 vol vi.
11. RONGY A J. *Am J Obst & Gynec* 1924 vol vii.
12. REBEN I C. *Am J Obst & Gynec* 1916 vol xii.
13. SCHMITT W. *Strahlentherapie* 1928 xxx, September.
14. STERN S. *Am J Obst* 1915 vol lxxii.
15. TITUS. Reported by Mundell J J. *Am J Obst & Gynec*, 1927, vol xiii.
16. Various authors. Quoted by Murphy.
17. WEYER D D and MAYER M D. *Am J Obst & Gynec* 1927 vol xiv.
18. ZAPPERT, J. *Wien Klin Wchnschr*, 1915 vol xxxviii.

## PREMEDICATION FOR LOCAL ANÆSTHESIA WITH INTRAVENOUS BARBITURIC COMPOUNDS<sup>1</sup>

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THE search for improvement in local anæsthetic methods must necessarily take two directions. Prolongation of the duration of the usual procaine epinephrin anæsthesia is one aim of further progress. This subject has been taken up in a previous communication (2) and a further report on the use of the suggested quinine derivative will be made in the future (3).

The preparation of the patient for an operation under local anæsthesia is another important problem. The psychic reaction of the patient, his fear and nervous tension in the operating room, may render the best local anæsthesia unsuccessful. This is particularly true of the nervous, irritable patient, especially the hyperthyroid. The usual preparation with morphine atropine may not always satisfy in patients under high tension. Morphine is an excellent analgesic but, in the absence of pain it may only nauseate the patient or he may become highly sensitive and irritable. Atropine causes a dryness of the throat and while the suppression of the bronchial secretion and the diminution of vagal reflexes are welcome under general anæsthesia the discomfort of the atropinized conscious patient is considerable. The use of scopolamine in doses of 1/100 grain to 1/300 grain is a great help but may occasionally produce toxic symptoms. Hallucinations, restlessness, and poor co-operation have been observed in youthful hyperthyroid patients. Scopolamine is most useful in prostatic cases in older patients, who slumber peacefully under a sometimes imperfect sacral block.

For several years I have been trying to find a suitable drug which would produce somnolence or superficial sleep without lessening the co-operation of the patient, and producing a deep anæsthesia. A number of papers from French and German clinics report deep surgical anæsthesia following the intravenous use of barbituric acid compounds. An article by Cleisz lists the French literature up to 1924. He describes 40 obstetrical cases and believes that the injection of 6 to 10 cubic centimeters of somnifen, a mixture of diethyl and dipropenyl barbituric acid is the best analgesic method in childbirth. A number of other French gynecologists praise the value of this barbituric mixture. In Germany the method has been given a thorough trial by Siegert who in-

jected from 2 to 8 cubic centimeters of somnifen intramuscularly. There were many untoward symptoms and he concluded that the method was not applicable in gynecology.

From this and other reports it seemed wise to me not to aim at a deep surgical anæsthesia but rather to use small doses in preparation for local anæsthesia.

It is sufficiently known that the safety margin of the hypnotics of the barbituric acid series varies a great deal. In a study of 350 albino rats Nielsen, Higgins and Spruth determined the safety margin of barbituric compounds as the difference between the minimum effective dose and the minimum fatal dose, expressed in the percentage of the minimum fatal dose. From this study it appeared to me that barbital and luminal in particular had a comparatively small safety margin and that neonal was best fitted for my purpose (Fig. 1).

### METHOD OF EXPERIMENTS

In the first series of experiments, conducted in 1925, 10 patients were injected intravenously with 2 cubic centimeters of a 20 per cent somnifen solution (Table 1). This uniform dose was given in order to observe the relation of the sedative effect to age, sex and weight.

While youth, female sex, and light weight may increase the effect of the drug to a certain extent, the individual response seemed to outweigh any other factor. The maximal drop in pulse was 14 points, in respiration 5 points, in systolic blood pressure 11 points, and in diastolic blood pressure 7 points, as an average in 10 cases. This drop is within the normal limits of what occurs in sleep and started 10 to 15 minutes after the injection. An immediate drop after the injection, which would mean a direct influence on the vasomotor and respiratory centers, did not occur in this series.

There was one complete failure (Case 10) in a patient with inoperable carcinoma of the uterus who had been taking morphine and sedatives for a long time. In a girl, aged 18 years, dehydrated and under weight (Case 2) a deep sleep followed the injection. In the other cases somnolence or light superficial sleep was induced in 9 minutes and lasted 48 minutes on the average. In both

<sup>1</sup>Presented at the meeting of the Society of Clinical Surgery, October 23, 1925 in Chicago.

cases of hyperthyroidism the effect wore off more rapidly, probably owing to the more rapid elimination in these patients. Case 7, after a superficial sleep for 10 minutes, got greatly excited, tossed about in bed, and showed a typical paradox reaction. She had been dismissed from an insane asylum 4 weeks previously. Such reactions will occur with morphine, luminal, and scopolamine too. In Case 9 an interesting amnesia was obtained in regard to the operation, although during the operation the patient answered clearly my inquiries concerning the recurrent nerve.

On the whole, there was a definite effect, with out any untoward symptoms, to be noted in the series. The effect, however, wore off too soon and its action was difficult to foretell. It must be remembered that the dose was only one fourth of that recommended for deep surgical anesthesia.

In the second series neonal, in amounts varying from 20 to 60 centigrams, was given intravenously (Table II). There are interesting points to be noted here. In a case of hyperthyroidism (Case 13) we obtained a good effect which was produced very rapidly and wore off in 20 minutes. The dose was only 20 centigrams. The same patient with the same dose was greatly excited in the operating room and a general anesthesia had to be given. In the case of a man with degenerative stigmata absolutely no effect was obtained with 30 and 50 centigrams (Case 14).

In Case 17 a patient who had carcinoma of the cecum with metastases was given 60 centigrams of neonal intravenously. The effect was instantaneous. He fell into a deep surgical anesthesia, with no corneal reflexes which lasted 50 minutes, and then slept whenever left alone during the next 14 hours. His systolic blood pressure dropped from 138 to 96, the diastolic from 110 to 82. His pulse remained full and regular, dropping only 0 points. The respiration dropped 6 points. His condition did not look alarming except for a slight cyanosis of his finger tips. Cyanosis was observed also in Case 14, that of a man who was operated upon under local anesthesia for an inguinal hernia. The cyanosis could not have been due to cardiac failure in either case but must have been due to an incomplete oxidation of hemoglobin.

In the third series of experiments subcutaneous injections were tried (Table III). Two cubic centimeters of a 15 per cent solution of neonal were injected into 7 patients. The injections were painful and left marked infiltrations for several days. One patient, although co-operative during thyroidectomy, had a complete amnesia concerning the operation. She developed a generalized

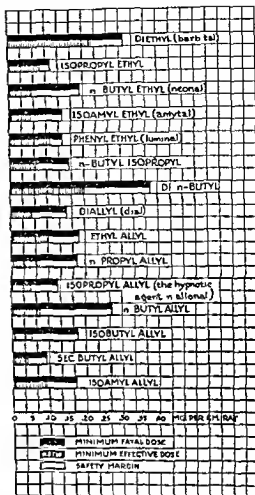


Fig. 1. Safety margin of barbituric compounds from Nielsen, Higgins and Spruth.

urticaria, probably the effect of medication, on the fourth day after operation. Three patients showed no effect at all. Another three were hardly affected.

In the fourth series oral medication was tried (Table IV). In addition to the customary dose of 70 centigrams (3 grains) of neonal or allonal the night before the operation I administered 20 centigrams three times on the day preceding the operation. Thus the patient received 20 centigrams in the morning, 70 centigrams at noon, and 40 centigrams in the evening. If necessary an other dose of 70 centigrams was given 2 hours before the operation. The patient thus received a gram of neonal in 24 hours, which is a considerable dose because the drug tends to accumulate in the body. In this series, 5 patients were not

TABLE I—EFFECT OF ONE AMPOULE OF SOMNIFEN GIVEN INTRAVENOUSLY\*

Case	Name	Sex	Age	Weight in kilograms	Diagnosis	Maximal drop in			Effect†	Onset in minutes	Duration in minutes	Remarks
						Pulse	Respiration	Blood pressure				
1	A G	M	30	56	Inguinal hernia	12		5-10	2	10	30	
2	K E	F	18	65	Cecal fistula	15	6	20-20	3	10	60	
3	J V	F	50	90	Cholelithiasis	15	10	10-15	1	10	6	
4	J J	F	45	85	Acute appendicitis	19	6	10-5	1	15	50	
5	S R	F	36	67	Tracheal fistula	20	2	5-5	1	10	110	
6	L P	F	41	70	Appendicitis 10 days ago	8	9	5-5	1	10	60	
7	B S	F	28	56	Epididymic pain hysteria	Plus 10	Plus 20	20-10	2 -2	10	30	Superficial sleep; patient became restless and complained of dry throat.
8	R G	F	32	55	Endophthalmic gonorrhea basal metabolic rate +40%	20	4	15-10	1	5	0	
9	S T	F	49	50	Hypertension + iodine + 15% at op.	13	4	16-8	1	15	40	Perfect anesthesia to closing operation.
10	M P	F	43	55	Carcinoma of uterus	2	2	6-4	0			Had had 1 1/2 of morphine and other sedatives.
Average drop						14	5	11-7				

\* 1 ampoule—a cubic centimeter of a 20 per cent solution (20 centigrams) of diethyl and dipropenyl barbiturate acid.  
 † 1 = excited restlessness; 2 = greatly excited; 3 = no effect; 4 = sleep; 5 = light sleep; 6 = deep sleep with perspiration; 7 = deep sleep with sedation.

TABLE II—EFFECT OF NEONAL INTRAVENOUSLY\*

Case	Name	Sex	Age	Weight in kilograms	Diagnosis	Dose	Maximal drop in			Effect†	Onset in minutes	Duration in minutes	Remarks
							Pulse	Respiration	Blood pressure				
11	E W	M	38	75	Anal fistula	2 cc 1% 10 <sup>60</sup>	7		2-10	2	20	30	
12	M K	F	18	47	Exophthalmic goiter basal metabolic rate +43	1 cc 1% 10 <sup>60</sup>			0-10	2	3	20	
13	Same	F	18	47	Exophthalmic goiter operating room	2 cc 1% 10 <sup>60</sup>				-2			Greatly excited; had to be put to sleep.
14	A H	M	4	50	Inguinal hernia	5 cc 1% 10 <sup>60</sup>	6	2	0-0	0			
15	Same	M	34	30	Inguinal hernia	5 cc 1% 10 <sup>60</sup>	4	1	5-3	0			
16	G H	F	44	50		6 cc 1% 10 <sup>60</sup>	2	2	0-0	1	10	30	
17	W E	M	65		Carcinoma of caecum with metastases	4 cc 1% 15 <sup>60</sup>	0	6	42-25	4	0	50 14 hr	Deep surgical anesthesia. Sp pt if not aroused.
18	D M	F	23	47	Thyroid gland carcinoma	1 cc 1% 15 <sup>60</sup>	5	2	0-5	-1 2	15	20	First tried to sleep.
Average drop							6		0-7				

\* Ampoules of 10 per cent and 5 per cent of neonal-ethyl barbiturate acid.  
 † Coded as explained in footnote to Table I.

affected at all and only 3 showed a real sedative effect. The disadvantage of keeping the patient in a somnolent state the day before the operation will be discussed later.

## DISCUSSION

A report on the 35 cases shown in the tables would hardly seem warranted. However, as I

have discontinued this premedication and as, recently, renewed interest is being shown in intravenous hypnotics publication seems worth while in spite of the paucity of data.

The outstanding feature of the barbiturate acid series particularly in intravenous dosage is the difficulty of foretelling the individual response. The patient's age, sex and weight influence the

TABLE III—EFFECT OF SUBCUTANEOUS NEONAL INJECTIONS IN 15 PER CENT SOLUTION

Case	Name	Sex	Age	Weight in kilograms	Diagnosis	Dose	Effect	Remarks
19	S S	F	52	61	Diffuse colloid goiter	2 c cm 15 <sup>th</sup>	1	Extensive rash on fourth day after operation
20	S F	F	55	70	Ventral hernia	2 c cm 15 <sup>th</sup>	0	Has taken alcohol for several weeks
21	P T	M	60	55	Duodenal ulcer	2 c cm	1	Sleepy but became wide awake in operating room
22	D S	F	35	61	Itamorrhoids	2 c cm	0	No effect
23	M D	F	55	62	Inguinal hernia	2 c cm	0	
24	G T	M	40	6	Amputation for gangrene	2 c cm	1	Slight sedative effect
25	R S	M	55	65	Trophic ulcers on leg perianterial sympathetomy	2 c cm	1	Slight sedative effect

\* See red as explained in footnote to Table I

TABLE IV—EFFECT OF ORAL DOSES OF NEONAL ON PRE-OPERATIVE CASES\*

Case	Name	Sex	Age	Weight in kilograms	Diagnosis	Effect†	Remarks
16	G S	M	70	66	Carcinoma of glands of neck	0	Nerve block was successful but patient showed no sedative effect
17	M H	F	28	47	Exophthalmic goiter	0	Same patient in bed 3 days after showed marked somnolence
18	M P	F	54	75	Ventral hernia	1	Slept after 1 hr later talkative
19	Same	F	54	75	Ventral hernia after operation	1	Marked relative effect in the room
20	E T	F	20	6	Exophthalmic goiter	1	Good pre-operative state
21	L P	M	70	65	Hypertrophy of prostate	0	
22	T S	M	38	56	Lipoma of back	0	
23	M L	M	40	55	Bleeding gastric ulcer hemoglobin 25%	1	Slept effect during the entire day
24	M S	M	51	60	Abscess of thigh	1	Slight effect
25	R C	M	50	54	Deltoid gangrene	0	

† 1 gram of neonal in 24 hours  
relieved in foot note to Table I

dosage to some extent but more important is the amount of anxiety which is to be overcome. An 18 year old girl with exophthalmic goiter became quite sleepy after the injection of 2 cubic centimeters of 10 per cent neonal (Case 12). The same patient a few days later received the same dose and was taken to the operating room where she became greatly excited and had to be put to sleep (Case 13). A similar experiment was made on a woman aged 54 years who reacted differently in her room from what she did in the operating room (Case 28).

The intravenous dosage in this series was about one fourth to one fifth of what had been recommended for obtaining deep surgical anesthesia. In Case 17 however a dose of 60 centigrams of neonal (4 cubic centimeters in 15 per cent solution) resulted in deep surgical anesthesia for 50 minutes, followed by a deep sleep for 14 hours.

While the pulse and blood pressure did not drop to an alarming degree a slight cyanosis was present. It was after this experience that I decided to give up the intravenous medication. In a young woman, weighing 56 kilograms, a dose of 40 centigrams of somnifen produced great restlessness, excitement, flushing of the face and dryness of the throat. Such individual and previously inestimable reactions make very difficult the use of intravenous sedatives, at least that of the two drugs which I employed. The effect wears off, in most cases, very rapidly, whereas the anesthesia sets in very quickly.

The subcutaneous medication was soon abandoned because of the pain at the site of injections and because of the slow absorption of the drug into the blood stream which made impossible its accumulation in satisfactory concentration. Perhaps intramuscular injections could be tried as

used by Siebert, to obviate the pain accompanying subcutaneous injections

The protracted oral medication resulted in just as many different individual responses as did the other forms of administration. Furthermore to produce a sedative effect, the patients were kept in a somnolent state an entire day before operation which hardly seems desirable. Their nutrition is thus impaired and the glycogen storage of the liver cannot be so well maintained. Prolonged sleep after the operation is equally undesirable. The patients are more apt to develop pulmonary complications and their nutrition, unless subcutaneous and rectal medication is resorted to is impossible. It is well known that patients who take barbitol for suicidal purposes quite frequently develop pneumonia.

On the basis of these few experiments I hesitate to say that analgesia or light sleep produced by barbituric acids is not feasible. With larger doses, I could readily have induced deep anesthesia as was obtained in one case. I feel however, that the advantage of inducing a rapid surgical anesthesia by the help of intravenous medication is offset by the uncertainty of the effect, by the prolonged sleep as in true barbituric acid poisoning, and by the inability to stop or counteract the effect of the anesthetic. This of course is the difficulty with all intravenous and rectal hypnotics.

There is only one type of case in which intravenous administration of the barbituric series seems well worth while. Hofvendahl advised intramuscular injections of 2 to 4 cubic centimeters of somnifen in cases of cocaine poisoning. Tatum and his co-workers found that the minimal fatal subcutaneous dose of cocaine in the dog was 26.7 milligrams per kilogram. This minimal fatal dose could be raised to above 100 milligrams per kilogram weight with the prophylactic administration of a mixture of barbital sodium and paraldehyde. Hence a fourfold increase in tolerance to cocaine resulted. Convulsions were completely and instantaneously controlled by an intravenous injection of the barbital paraldehyde mixture. In addition however, Dragstedt and Lang found that atropine would exert the same protective influence in case of cocaine poisoning.

It might be well worth while to consider an intravenous injection of one of the soluble barbituric acid derivatives, such as somnifen, neonal, or amytal, in cases of acute novocaine poisoning, with convulsions, which almost invariably is the result of an intravenous injection. On the basis of Dragstedt and Lang's study it would appear that atropine could also be used.

#### SUMMARY

An attempt to produce, in patients operated upon under local anesthesia a state of somnolence or light sleep by means of intravenous subcutaneous, and oral doses of hypnotics of the barbituric acid series is described. Because of great individual variations, this attempt was not successful and was given up after trial in 35 cases. It is possible that larger doses and other derivatives may give a more uniform effect. The protective action of the barbituric compounds against poisoning with cocaine and its derivatives is pointed out.

NOTE.—The patients were selected from my service at the Surgical Clinic of the University of Budapest and at the Wesley Memorial Hospital Chicago. Drs. Allen B. Kanavel and Charles A. Elliot kindly permitted the use of some of their cases for which many thanks are due.

#### BIBLIOGRAPHY

1. CLEISS, L. L'anesthésie obstétricale par injection intraveineuse de somnifène. *Presse méd.* 19 4 xxxv 1004-1005.
2. DE TARATY, G. Prolongation of local anesthesia. *Sur. Gynec. & Obst.* 19 6 xlii 100-105.
3. DE TARATY, G. and O'CONNOR, T. P. The use of a quinine derivative in tonsillectomies. *In press.*
4. DRAGSTEDT, C. A. and LANG, A. F. Respiratory stimulants in acute cocaine poisoning in rabbits. *J. Pharmacol. & Exper. Therap.* 1928 xxxi 215-222.
5. HOFVENDAH, A. Die Bekämpfung der Cocainvergiftung. *Praktische Ratschläge. Acta Oto-Laryngol.* 1922 ix 235-244.
6. NELSEN, C., HIGGINS, J. A. and SPENCER, H. C. A comparative study on hypnotics of the barbituric acid series. *J. Pharmacol. & Exper. Therap.* 19 5 xvi 371-381.
7. SIEBERT, F. Versuche mit Somnifen in der Geburtshilfe. *Zentralbl. f. Gynaek.* 1922, xlii 748-752.
8. TATUM, A. L., ATKINSON, A. J. and COLLINS, K. H. Acute cocaine poisoning: its prophylaxis and treatment in laboratory animals. *J. Pharmacol. & Exper. Therap.* 19 5 xvi 325-336.

# THE ANTHROPOLOGY OF THE NEGRO, ITS BEARING ON THE MORTALITY IN HEAD INJURIES

## A REVIEW OF SIX HUNDRED CASES

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WITH the development of fast moving, high powered automobiles and the simultaneous appearance of a tragic disregard for law and the rights of others, the number of head injuries is rapidly increasing year by year, and the negro is receiving more than his proportionate share of such injuries. This is the result not only of his lesser degree of judgment—in many instances decreased by alcoholic intoxication—but also of his at least equal, if not greater, amount of indifferent recklessness.

For generations head injuries, especially fractures of the skull, have been viewed by the layman particularly as a most melancholy affair. There is no gainsaying the fact that even with the more scientific management of today, head injuries frequently have a tragic ending.

When one contemplates, from an anatomical point of view the infinite care with which the brain and spinal cord have been protected—the skull, enclosing the entire brain thickened where the impact is most likely to land the dural covering the strongest membrane in the body limiting turgescence and affording physiological rest, and the choroid plexus, a safeguard against infection—it prompts the conclusion that the brain, with its myriads of delicate nerve fibers is, of all the organs of the body least capable to care for itself.

My first memory of fear was occasioned by a negro idiot, Buck King by name in my native county of Upson. He had flat feet, his skull was of the scaphocephaloid type, and his lips were thick and protruding—the lower lip even drooping. His head was his only weapon and he revenged all his imaginary grievances by pinning against a wall the person whom he took to be the offender and butting him in the abdomen. My knowledge of this characteristic was no doubt the foundation of my well grounded opinion that a negro head would withstand much punishment. This idea seems prevalent throughout the southern states, and doubtless has existed for many years for in Dr S Wier Mitchell's *South of George Washington* the following incident illustrates this belief.

I had been told, of a Sunday morning of a great flock of ducks of the kind called canvasback and much esteemed. It was against our habits to

shoot on this day, but towards evening, the temptation being great, I went to the shore and was about to push off, when Peter, using the liberty of an old family servant, said I would make Mr Fairfax and my brother, then like myself at Belvoir, angry if I went. When he held on to the prow to stay me, I suddenly lost my temper and struck him with an oar on the head. He fell down and lay in a sort of a shake. I thought he was killed, and had he been white I must surely have put an end to him, but the blacks have thick skulls, and presently he got up and staggered away, his head bleeding."

Prompted by this statement and the knowledge that the Surgeon General's Library possessed no literature on this particular phase of head injuries, I concluded it would be interesting and timely to take advantage of the excellent opportunities afforded me to make a clinical study of a long run of head injuries in negroes, as compared with an equal number of similar cases in whites, in order to determine if there were any clinical foundation for this prevalent idea that a negro's head was more difficult to injure than a white man's.

It is an established rule in physics that a hollow sphere of smaller diameter will stand more stress and strain than a sphere of equal thickness but of greater diameter. That being true, it stands to reason that if the smaller sphere is also thicker, the resisting strength will be increased in direct proportion to the thickness. As to the size and thickness of the negro skull, no less an authority than Hrdlicka, of the Smithsonian Institution, says "It is quite true that the skull of the American negro and that particularly where there is some scaphocephaly, is thicker than that of a white man. The excess, however differs on the average I should say the negro skull is at least one third thicker than that of the average white American. As to the size of the negro skull it is generally smaller than that of the white man, stature for stature."

A H Keane (5), of London says "The chief points in which the negro either approaches the *Quadrumana* or differs most from his congeners, are among others, No. 3, Weight of brain, as



indicating cranial capacity, 35 ounces, highest gorilla 20 ounces, average European 45 ounces No 8, Exceedingly thick cranium enabling the negro to butt with head and resist blows which would inevitably break any ordinary European's skull."

Davis makes the following statement "The skull is thinner in the white than in the negro race" while Brinton in *Races and People*, states that cerebral or cranial capacity has been proved by investigation to average less in the negroes than in the whites. To be more exact, the average weight of the white man's brain is 1,475 grams, of the negro's brain, 1,331 grams.

Trotter in writing on the vulnerability of the brain mentions Spencer's pioneer investigations of cerebral hemorrhage in the newborn some 30 years ago and continues "We have seen that the European skull does not protect the enclosed brain from injury so efficiently as does the African skull. This must be because the latter is the stronger and more rigid. From the anatomical point of view this superior strength is evidently not very striking, since as far as I know, it has attracted but little attention and led to no attempt being made to measure it. From the functional and medical point of view the superior strength of the African skull is at once obvious and is plainly a very important racial character. The relative slightness and flexibility of the European cranium is then a leading character of the race and brings with it gross functional disadvantages in the resistance of injury."

Thus we are again face to face with the inevitable law of compensation while the Caucasian is endowed with better reasoning power than the negro so to enable him to avoid injury the skull of the negro offers much greater resistance to injury than does the skull of the white man.

Since it is known that a hollow sphere of a certain diameter withstands more stress and strain than a sphere of larger diameter that the highest authorities agree that the negro's skull is not only smaller but also thicker than the white man's that the relative slightness and flexibility of the Caucasian's skull brings with it gross functional disadvantage in the resistance of injury that Bean in his measurement of 103 brains and study of 10,000 individuals has classed the southern negro with the Guinea Coast negro the most ancient and the most classical negro type—it is a logical deduction that study of a large series of head injuries in negroes in the South would show the effects accurately with a decidedly small death rate as compared to that in an equal number of such injuries in the whites.

With a view of obtaining the most accurate statistics possible, 300 cases in the white race have been compared with 300 cases in the negro. To these two groups of cases there has been applied the same classification of injuries resulting from practically the same causes and the same underlying principles have governed the type of treatment in both groups.

Only cases showing definite brain damage such as bloody spinal fluid fractures, unconsciousness, semi-consciousness, bleeding at ears, paralysis, exophthalmos, tinnitus, aphasia, nystagmus vomiting have been considered.

The same routine study has been made in every case a rough neurological examination several blood pressure readings at short intervals roentgen ray examinations of skull showing antero posterior and lateral stereo-copic views spinal puncture to detect blood in the fluid, spinal fluid pressure reading with an Ayer manometer and ophthalmoscopic examinations of eye grounds.

#### TREATMENT

Frequently patients with head injuries when first seen are in a state of profound shock. Regardless of the type of injury, the shock must be combated until the patient reacts favorably, before routine examination is attempted.

In head injuries two types of disturbance should be considered and examination when completed should enable one to classify a given case as one or the other of two groups (1) that caused directly by the force of the blow and showing immediate symptoms, such as hemorrhage, concussion with temporary unconsciousness and depressed fracture with possible localized paralysis, torn dura and contused brain and (2) that resulting from external force but never coming on instantaneously but after certain intervals manifesting themselves either by hemorrhage or gradually developing edema of the brain. In other words head injuries may be divided into two main groups (1) operative and (2) non operative. In the operative cases surgical interference is resorted to only when there is something to be removed such as a large blood clot, depressed bone, badly damaged brain tissue or a subdural accumulation of fluid. Among the non operative cases are those of simple concussion or potential brain damage with or without fracture which experience teaches will recover with the help of dehydration and a hypertonic diet—the larger group of cases. Given a patient with a head injury who is semi-conscious or unconscious possibly with a linear fracture perhaps with bleeding from one ear, with bloody spinal fluid but with blood pressure nor

mal or only moderately elevated, one may reasonably expect recovery with dehydration and hypertonic diet. Adults are given  $\frac{1}{2}$  ounce of a saturated solution of magnesium sulphate every 2 hours for 24 hours, then the same dose every 4 hours for another day, gradually lengthening the intervals daily for 1 week, when the magnesium sulphate may generally be discontinued. The dose for children should be regulated according to age, 1 to 2 drachms every 4 hours. Should magnesium sulphate cause too frequent evacuations, they may be controlled with paregoric or a small dose of codeine. If the patient cannot swallow, 10 cubic centimeters of a 10 per cent solution of magnesium sulphate may be given intravenously daily.

The diet should be a combination of hypertonic and dry, very sweet fruit ades, salty broths, dry foods, and no plain water.

Spinal punctures should be made daily until spinal fluid clears up. Luminal or bromides are to be given for extreme restlessness.

A bleeding ear should never be syringed out. Instead it should be wiped out with sterile cotton, a few drops of a suitable antiseptic introduced, and the canal kept plugged with sterile cotton.

Patients with wild delirium must sometimes be restrained, they should be isolated from all relatives and kept quiet by retention enemas of 2 drachms of paraldehyde in milk or water according to circumstances.

Frequently the irritative stage of a large hæmorrhage closely resembles alcoholic excitement; the venous engorgement resulting from increased pressure causes the patient to become irritable, excited, and even resentful. Careful watching of these patients for several hours may prevent a very embarrassing situation.

Patients with ruptured meningeal artery and depressed fracture should be operated upon. A torn dura and contused brain is often found associated with such fractures. One of the delayed conditions is a subdural accumulation of bloody fluid which manifests itself either by increase of intracranial pressure or by localized irritative symptoms, such as the jerking of a hand or foot.

Probably the type of case which most urgently calls for operative interference is the middle meningeal hæmorrhage in which the patient shows a temporary unconsciousness followed by an interval of consciousness, a slow bounding pulse following a slightly rapid small pulse, a gradual relapse into unconsciousness, with ster-torous, snoring breathing and perhaps a gradually developing hemiplegia or contralateral convulsions. These patients demand immediate sub-

temporal decompression with ligation of the ruptured meningeal artery. The patients with subdural accumulation of fluid also call for this type of operation, in which the dura is opened to allow the fluid to escape. A typical case of several days' standing might be relieved by a small trephine opening with a small opening in the dura.

Depressed fracture should be trephined away, the dura opened, clots removed, and damaged brain tissue removed by catheter suction. A short piece of a No. 20 F catheter on a Luer syringe is used. After all damaged brain has been removed the dura should be tightly closed.

Occasionally, in an infant, because the dura is closely adherent to the skull, a depressed bone will tear the dura, allowing the fluid to leak out and cause a hydrocele of the scalp. Opening the scalp and suturing the tissues tightly over the rent will relieve the situation until the suture lines unite and the fontanelles close.

Scalp wounds are often considered too lightly. They should be regarded as potential brain abscesses. The scalp should be shaved over a generous surrounding area, which is then thoroughly cleaned with the patient under novocain (1 per cent) and adrenalin (3 minims to 1 ounce) anesthesia. The ragged edges of the wound should be trimmed carefully away and the galea closed with fine catgut or interrupted silk sutures. The outer skin also is closed with interrupted silk sutures, which should be removed in 2 or 3 days. Neither through and through sutures nor colloidion dressings should ever be used.

From Table 1 it is seen that with conditions as nearly alike as possible in 300 cases of white patients and 300 of colored patients, 83 of the former resulted in death while only 48 of the latter terminated fatally, making the death rate in the white cases 27.6 per cent and in the negro cases 16 per cent.

It is particularly noticeable that there were 71 massive injuries among the whites as compared to 31 injuries of the same type among the negroes. While there were 48 depressed fractures among the negroes and 33 among the whites. The latter difference may be accounted for by the fact that the force of the blow was expended in only fracturing the skull in the negro cases, while a massive injury resulted in the white cases—conclusive proof in itself that the skull of the negro will withstand at least twice as much stress and strain as the skull of the white man.

Some of the valuable lessons learned from the study of this long run of cases are as follows:

1. A patient in a state of profound shock should be treated first for shock.

TABLE I—SUMMARY OF CASES

<i>Massive injuries</i>		White	Negro
Ages in years			
1 to 5		5	2
5 to 10		7	2
10 to 20		14	6
20 to 30		9	9
30 to 40		9	7
40 to 50		8	3
50 to 60		8	2
60 to 90		11	0
Total cases		71	31
Total operations		14	3
Deaths		71	30
<i>Meningeal hemorrhage</i>			
5 to 10		1	0
20 to 30		1	0
30 to 40		2	0
40		0	1
Total cases		4	1
Total operations		3	1
Deaths		2	0
Cured		2	1
<i>Depressed fractures</i>			
1 to 5		6	2
5 to 10		10	4
10 to 20		7	0
20 to 30		2	15
30 to 40		5	12
40 to 50		0	5
50 to 60		1	0
60 to 90		0	1
Total cases		33	48
Total operations		29	38
Deaths		3	10
Cured		30	38
<i>Hypertonic cases—non-operative</i>			
1 to 5		33	12
5 to 10		29	9
10 to 20		52	64
20 to 30		27	53
30 to 40		17	35
40 to 50		15	15
50 to 60		9	7
60 to 90		8	3
Total cases		190	218
Deaths		5	6
Cured		185	212
<i>Deep hemorrhages</i>			
1 to 5		0	0
5 to 10		0	0
10 to 20		1	1
20 to 30		1	0
30 to 40		0	0
40 to 50		0	1
50 to 60		0	0
60 to 90		0	0
Total cases		2	2
Operations		2	2
Deaths		2	2

until the patient regains consciousness, in order to avoid pneumonia.

4 Morphine should not be given for severe headache following a head injury, for the drug depresses respiration and may disguise a dangerous meningeal hemorrhage.

5 The patient should not be allowed up too early, or the result may be an intractable headache.

6 A normal pulse rate and blood pressure may be misleading in a case in which meningeal hemorrhage is suspected. A dangerous hemorrhage can come about with a blood pressure of 118 and a pulse rate of 80.

7 Care should be taken not to overlook a contrecoups hemorrhage in an unconscious patient. The scalp wound, or fracture, may be on one side and the hemorrhage on the opposite side.

8 The depletion of a patient whose system is already impoverished by the loss of a large amount of blood may result fatally.

9 Operation upon a patient with a fast falling blood pressure will prove fatal.

10 Great care must be taken to distinguish between the irritating stage of a large hemorrhage and a state of alcoholic excitement. Often it is absolutely impossible to distinguish one from the other for the time being.

11 Puncture wounds of the cranium such as wounds from ice picks and knife blades, should be explored immediately.

Though the much greater death rate of the whites might be taken to presuppose a greater vulnerability of the brain in the white race, the excess of massive injuries in the whites makes it clear that 'the vulnerability is due to the failure of the protective function of the skull.' Since this failure of the protective function brings with it gross functional disadvantages in resistance to injury, we may assume with Trotter that 'it has some deep and real significance in compensation.' As he further says, it 'paid the European, so to speak, to develop a type of cranium which put him at a serious physical disadvantage in contest with his primitive competitors and even with contemporary races of today. What can have been the price he got in return that prevented the transaction from being the bad bargain it so manifestly might have been but was not?'

## BIBLIOGRAPHY

1. ROBERT BENNETT BEAN. *Am J Anat* 1906 v
2. DAVIS. *Applied Anatomy*
3. HEDLICKA, A. Personal communication.
4. *J Psychol Med* 1867 1, No 11
5. WILLIAM B SMITH. *The Color Line*
6. WILFRED TROTTER. *Brit M J* 1924 1, May 10.

2 X-ray pictures should not be taken until the patient reacts from shock.

3 If the patient is unconscious or semi-conscious and the head injury is complicated by a fractured limb, a body cast should not be applied

# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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FEBRUARY 1930

### RELATION BETWEEN ACUTE INFECTIONS OF THE UPPER RESPIRATORY TRACT AND INFECTIONS OF THE KIDNEY

FOR many years attention has been called periodically to the apparent frequency of pyelitis in children coming with or subsequent to acute infections of the upper respiratory tract. However, the precise relationship between these two factors and the question of whether indeed there is any relation at all has been obscure.

The organisms concerned with the throat infection are commonly various cocci while the organism which appears to be the causative agent in the kidney infection is most commonly the colon bacillus. Most painstaking work by Helmholz and others has failed to explain the illusive relationship. Again Rose and other workers following the lines which he has indicated have concerned themselves with the relation of chronic foci such as those in tooth and tonsil to infections of the urinary tract, but again the organisms concerned have commonly been widely different and the exact relationship has remained ob-

scure. In sharp contradistinction to these facts which have defied accurate correlation, is the well known relation between acute infections of the skin and bone with acute infections of the kidney. It is a matter of common knowledge that patients with boils, carbuncles, and acute osteomyelitis occasionally develop acute infections of the kidney with the staphylococcus, which is the causative agent of the primary infection. Here the relationship is generally clear and definite and the organisms found in both lesions are the same.

For several years we have been interested in observing a group of patients, most of whom have perhaps accidentally, been young adults of both sexes who, coincident with some acute infection of the upper respiratory tract, commonly a tonsillitis, have had the following clinical picture. At some stage during the throat infection never at its beginning, the patient has pain varying from one of moderate intensity to one of great severity occurring in one or the other rarely in both, renal regions. This is accompanied by definite costovertebral tenderness occasionally by spasm of the anterior abdominal muscles, commonly by nausea, occasionally by vomiting. The fever rises sharply, often to 103 or 104 degrees. The leucocytosis which has heretofore been moderate rises definitely, often reaching 20,000 or more. In these patients, by ordinary routine methods of examination the urine is habitually normal. However, careful examination of highly centrifuged, very fresh specimens which in the female must be obtained by catheter and in the male must be the terminal portion, will regularly show cocci in large numbers. In the overwhelming majority of

these patients, the fever persists for a few days, the tenderness, leucocytosis and cocci in the urine remain for the same period. Then all the symptoms gradually subside, the cocci disappear, and careful check up has appeared to show that the patient had entirely recovered.

We have come to believe that this clinical picture is considerably more common than has been generally supposed, that such attacks, often relatively mild, are fairly common and that they are in fact evidence of acute renal infections, we believe of the cortical type, which go on to spontaneous recovery.

I desire to call attention to this group since I think it will bear wider study but I also wish to call attention to a group of cases which follow from this clinical picture and which seems to me may possibly throw light upon the whole question of renal infections through the blood stream in the previously undamaged kidney. A certain proportion of these cases, instead of going on to spontaneous recovery, continue to show the clinical picture before suggested except that the fever continues, the kidney can be demonstrated to be definitely enlarged, and pus in small quantities not rarely appears in the urine. At the end of two or three weeks the process begins spontaneously to recover but commonly enough, colon bacilli will appear in the urine as the cocci are disappearing and as the pus begins to show. There is here, I think, a suggestion that the colon bacillus is more often than we have believed, a secondary invader, its rapid growth in the urine may easily be misleading since the bacilli can increase enormously during the time the urine remains within the body. In this way they will obscure the examination of the urine as made by centrifuge, smear and stain, a method upon which we have come to rely more than upon culture. However, the

possibility of overlooking cocci in the presence of an overgrowth of colon bacilli is perhaps equally as likely in culture as in smear.

As far as I know there is very little evidence of the condition of the urine in children with acute upper respiratory infections until pus is found and a pyelitis more or less acute is well established. It seems to me not impossible that the organisms involved in the upper respiratory infection may in fact be those which first invade the kidney, first reduce its vitality and make it a congenial abiding place for the more or less ubiquitous colon bacilli. The field is, I think, one which will continue in the future, as it has in the past, to repay careful study.

HUGH CASOT

## HYSTERICAL LITHIASIS

TO the various types of urinary calculi which are usually described in the literature should be added a form of lithiasis, or rather pseudo lithiasis which is not generally recognized and which from its nature may well be termed "hysterical lithiasis." This unusual manifestation of abnormal psychological process is manifested by symptoms simulating acute renal colic. In order to complete the deception, the patient will produce a stone shortly after the colic, which to the casual observer may be mistaken for renal calculus. In addition, one patient following the pseudo colic, was able to demonstrate hematuria, which on examination proved to have its origin in a self inflicted perineurethral abrasion. Although renal colic is simulated by some patients in order to secure a desired drug in most instances this unusual form of invalidism is assumed to obtain attention and sympathy. Two of the patients had previously passed true renal calculi and one patient had had a stone removed from her kidney, so that they had no difficulty in

simulating actual renal colic. Several patients inserted a calculus into the bladder prior to roentgenographic and cystoscopic examinations. One patient carried a small bag filled with pebbles, which she surreptitiously placed in the lumbar area at the time of roentgenographic exposure. That it is easy to confuse the symptoms accompanying this form of psychoneurosis with those of true lithiasis is shown by the fact that in none of the cases had the condition been recognized at first and in each instance several physicians had treated the patient in good faith for actual lithiasis.

As a rule the stones which are claimed to have been passed can be recognized as foreign material by anyone who has previously observed renal calculi. They frequently consist of small, round pebbles, and in order to keep up the semblance of veracity the patient usually will select the same type. In several instances the stones selected were irregular

and glistening. One patient presented pieces of chalk, and another bits of plaster which were dug out of the wall with the finger nail, and when crumbled resembled somewhat a soft phosphatic stone. On the other hand, urinary calculi are sometimes observed which have such a bizarre appearance that their origin may be doubtful. If there is any doubt as to the nature of the stone a chemical analysis will, of course, identify it.

Although the deception will be indignantly denied by most patients when first informed of the situation, the cure will usually be miraculous. Several patients, however, were known to continue their stony career. One patient claimed to have passed over 200 stones at regular intervals. The possibility of pseudo lithiasis should be considered with every case of chronic stone forming kidney and an analysis should be made of the stones to determine their organic origin.

W F BRAASCH

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HUGH CLEGG

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ROBERT F WEIR  
1838-1927



# MASTER SURGEONS OF AMERICA

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## ROBERT F WEIR

FOR a surgeon, the year 1838 was a good time to be born. Within the years of Dr Weir's lifetime, surgery made most astonishing and important advancement, and during this period Dr Weir witnessed the surgery of three American wars, and he himself achieved much. To live to be ninety years old is of itself some achievement. It is fortunate for the historian that the subject of this sketch left some private personal reminiscences of his early life which, through the kindness of his only child and daughter, Mrs La Montagne of New York City, we are permitted to record.

I had graduated, the youngest in my class from the just established New York Academy (later the College of the City of New York) and had started as a clerk with my father, who was an apothecary in Grand Street. Dr H B Sands, who later achieved great eminence, was also the son of an apothecary. During the two or three years I was acting as a clerk, I rose from taking down and putting up the store shutters to become quite expert in the manufacture of unctures, etc., and acquired, thanks to a pleasing and diligent perusal of Wood and Bach's *Dispensatory*, quite a fair knowledge of medicines and their actions on the human body. Perhaps this training inclined me to the practice of medicine, but I have always been convinced that two incidents determined my career. The first was the experience I obtained from the painful ingrowing toe nail of my big toe. It plagued me so badly, for several months until my father sent me one Saturday to the office of Dr James R Wood, whom I had frequently seen in our store and who was generally known by all the neighborhood as 'little Dr Jimmy Wood'. His office was at the corner of East Broadway and Market Street (and they were fashionable streets then). There he held once a week a sort of clinic for his numerous students. Thither I went in due time and was ushered into his sanctum. He examined my stripped toe and while explaining to the embryo medicos the nature of the trouble, slyly took up a pair of pincers and quickly placing one jaw of this under my nail, clamped the upper jaw to and pulled the nail out. I gave a jump and a wild yell, but it didn't hurt so much as I thought it would, since the nail had been considerably loosened by the prolonged inflammation and suppuration. I went home relieved, and telling my father of it, I said I'd like to be able to do like that. (This impression was augmented when a few months later his father sustained a Pott's fracture and was treated by the same Dr Wood.) The next day I announced my firm determination to become a surgeon.

How interesting it would be if other great surgeons had left biographical notes of the early mainsprings of their careers!

Dr Weir entered the office of Dr Gurdon Buck (of Buck's extension fame) as pupil and assistant and became a student at the College of Physicians and Sur-



ROBERT F WEIR  
1838-1927



geons "Dr Buck was a large man with a face somewhat German in aspect, slow in action and in speech, but having a thoughtful mind and fertile in surgical expedients" Dr Weir remained with Dr Buck three years. He tells a story of how one day, in giving ether for him, he diligently palpated the right eyeball of the patient (the method then in vogue to tell if the patient was under the anæsthetic), only to find after embarrassing cries and struggles of the patient, that he was the possessor of a glass eye! Later Dr Weir acted as Dr Buck's first assistant when he put on his first Buck's extension at the New York Hospital.

Dr Weir tells of an amusing incident at the graduating exercises of his college. The seats of the auditorium had recently received a heavy coat of varnish—too recently to become thoroughly dry. When the audience started to arise at the conclusion of the exercises, they found that they were almost glued to their seats. Dr John C Dalton who gave the address remarked that the students followed his words with fixed attention. Dr Weir offered as his graduating thesis, "Hernia Cerebri," for which he received a prize of fifty dollars.

In 1856 Dr Weir became an interne, or "junior walker" as it was then termed, at the New York Hospital which was started by Dr Bard away back in 1769.

It is interesting to read Dr Weir's account of the method of procedure at the New York Hospital for what were considered major operations at the time when he was house surgeon (about 1858).

The senior walker was expected to lay out the instruments they had been resting on a velvet lined shelf or were bedded in velvet lined slats in an adjoining closet. He would make inquiries of the nurse, who was at other times a ward nurse, about the sponges which, having been washed out from a previous operation, had been kept in a wooden pail of fresh water. Fine, beautiful and soft looked they when taken from the pail out of the water and placed in a basin for the nurse or one of the walkers to hand to the surgeon during the operation. Sometimes the surgeons washed their hands previously—sometimes not. Fingers laden with germs in large quantities on them or under the nails were stuck into the wounds we made and we further introduced (alas! all this was unconsciously done) infectious and often fatal germs by the brilliant and apparently clean instruments we employed. After we had done all this we tied blood vessels with strings with long ends so that we might pull them out when they loosened themselves from the tied arteries. Furthermore, we dressed our wounds with wax cerates kept in jars open to germ laden dust and smeared over lint with foul spatulas."

In 1861, Dr Weir, desiring to enter the regular U. S. Army Corps, went up for the required examination. Concerning this, here are Dr Weir's own words: "During the examination I thought my chance of passing was gone when the chairman of the board asked me in sharp tones to give the treatment for pneumonia. But, he said, 'you have not mentioned blood letting. Wouldn't you employ it?' 'No,' I replied, 'I wouldn't.' 'But, Dr Weir, if I had pneumonia, wouldn't you bleed me?' 'No,' I firmly replied, 'that day has gone by.' 'Then I wouldn't like to have you for my doctor,' retorted he. But his bark was worse than his bite, for I passed."

On the way to Frederick, Maryland, Dr Weir was received by Lincoln at the White House, and was again presented to him when Lincoln came to Frederick.

The hospital at Frederick of which Dr Weir was chief was in proximity to the battlefields of the Shenandoah, South Mountain, Antietam, and Gettysburg. He saw it rise to a capacity of 3,000 patients and his assistants increased in number to 25 exclusive of the "medical cadets." From 1862 to 1865, Dr Weir had charge of the "United States of America General Hospital" at Frederick, Maryland, one of the Government's largest hospitals, and for his services was publicly thanked in the general orders of the Surgeon General's office. It is interesting to read in a recent personal communication from Dr W. W. Keen

At the battle of Antietam I was in charge of the Ascension General Hospital in Washington. I was ordered to Frederick, Maryland, in the neighborhood of Antietam and was Weir's first assistant in the administration of the hospital there, more especially in the supervision of all the capital operations. Either he or I had to approve of them before they were done because many of those who had patriotically volunteered were without a fundamental knowledge of surgery.

Weir was a capital operator, careful, judicious and resourceful. I have hardly known a better one. He also ingeniously suggested that in certain cases where the appendix had to be removed, the stump should be sewed first in the abdominal wall leaving the aperture of the stump in the abdominal wall. By this means we would be able to wash out the whole of the great bowel at any time and to any extent, and when the necessity ceased the small opening of the appendix in the abdominal wall was closed. He was indeed a Master Surgeon.

In the *Transactions of the American Surgical Association* for the year 1907 appeared an obituary notice written by Dr C. L. Gibson of New York City.

Dr Weir was president of the American Surgical Association 1900-1903. He had not been active a number of years before his death and had survived a brilliant group of surgeons who have left their impress on American surgery—notably Sands, Markoe, Thomas Ball, McBurney, McCosh, Hartley and Gerster. His Civil War record was marked by extraordinary achievement. He was always an indefatigable worker in research and was always in the front rank of progress—a distinguished leader, and many of the brilliant members of the American Surgical Association owe much of their development to his personal example and interest.

His greatest activity was in an epoch when pioneer work was being done along many lines of surgery and he had his share of success. He was one of the early workers in brain surgery. He made a great many contributions to surgical literature.

Dr Weir was a handsome man of striking personality and his fine character invited much affection and loyalty, especially of his younger associates. He was also a great traveler and his reminiscences and experiences are most interesting and valuable.

Dr M. Allen Starr, who was intimately associated with Dr Weir for so many years in college work, addressed the New York Academy in 1927 as follows:

As Professor of Surgery in the College of Physicians and Surgeons from 1873 to 1903, he taught many of the men of this country, now distinguished, who came from all parts to attend his clinics and to watch his operations and he imbued them with enthusiasm for their profession as well as sound knowledge of its principles. His wide experience gained chiefly in the Civil War in which he served as surgeon in charge of the hospital

at Frederick Maryland, his ample knowledge of surgery gained by familiarity with home and foreign literature, his skill in the varied lines of operative work, all combined to place him in the front rank of the surgeons of his time. And his genial nature, delightful personal manner, wide interest in art and letters and life outside his profession added to the esteem and affection with which he was held by his friends. He visited Europe many times and also went to Japan and China.

As attending surgeon in the New York Hospital from 1876 to 1903, he was an indefatigable worker without regard for financial return, for at that period the hospital was given over to charity patients and *private wards were not opened* (italics mine). This industry is evident by the very long list of his publications in the medical press during these years, more than a hundred being mentioned in the *History of the College of Physicians and Surgeons* published in 1900. During this period the introduction of Lister's methods of antiseptic, and later aseptic surgery was the subject of the greatest interest and Professor Weir was among the first to adopt, urge, and teach modern methods which eventually revolutionized surgical procedure. While his chief work was in abdominal surgery, he was the first in this country to operate for a brain tumor, under the direction of Sequin, and the success of that operation led him to make many contributions to the surgery of the head and brain. There is hardly any field of surgery in which his published articles do not increase knowledge. And his diagnostic wisdom and good judgment combined with his skill in operative procedure added to his reputation and in many lines made him the chief authority of his time.

He was elected president of the American Surgical Association in 1900, member of the International Surgical Association, president of the New York Surgical Society, of the Practitioners' Society, of the New York Academy of Medicine, and of the Greater New York Medical Society. In 1895 he was made a corresponding member of the Société de Chirurgie de Paris, and in 1905 an honorary fellow of the Royal College of Surgeons of England. Of this latter appointment it is interesting to note that Dr Weir, Dr Keen, and the Prince of Wales received this honor at the same time. It was the first occasion that an honorary degree had been bestowed by that body.

During his extensive practice in New York City, he had associated with him as partners Dr Robert Abbe, Dr Gibson and Dr Ellsworth Eliot, all whom became eminent. Dr Eliot, in a personal communication, writes "Dr Weir never developed a hobby although he tried hard on the tennis court and whist table. By his internes he was affectionately called 'Bobbie' and of this he was aware."

A few months after the organization of the American College of Surgeons in Washington, D. C. Monday evening, May 5, 1913, Dr Weir at the first convocation held in Chicago, November 13, 1913, was made an Honorary Fellow. The only other surgeons so honored were Sir Rickman J. Godlee, London, William Stewart Halsted, Baltimore, William Williams Keen, Philadelphia, and John Collins Warren, Boston.

Many honors were bestowed upon Dr Weir, he had appointments on the staffs of many hospitals and belonged to the principal medical societies of his time.

JOHN HAMMOND BRADSHAW

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN M.D. F.A.C.S. OMAHA, NEBRASKA

### THE PHARMACEUTICAL AND SURGICAL PHILONIUM OF VALESIO DE TARANTA

IN Europe from the beginning of the Middle Ages instruction in and practice of the sciences passed gradually into the hands of the clergy. Naturally of all the sciences surgery and secondarily medicine suffered the most. The dictum that the Church abhors blood prevailed and such surgery as there was was performed by itinerant charlatans and mountebanks. The literature of medicine save for the little that was preserved by the Benedictines was practically lost. The hospitals and schools established by the Romans became little more than homes or resting places for the poor and indigent. Then a change for the better began. Constantine Roger Roland and the four masters began their work at Salerno. The former translated the works of the ancients and re-established the result of their labors as a new literature in Europe. Roger and Roland wrote individual works and with the swing of medical education and instruction to the north Montpellier became the outstanding school and Guy de Chauliac and John Arderne wrote their individual works in surgery. But still there was no general compendium or text-book so to speak and the literature was hard to find and when found only fragmental.

Valesio de Taranta was a Portuguese who had studied in Lisbon and was attracted to Montpellier where he continued to study. He says that he began to practice medicine in 138 and as he precedes his discussions of diseases throughout his book by a short description of the anatomy of the part involved one may gather that he had taken advantage of the fact that from 1376 on a dissection of the body of a criminal was permitted annually at the school of Montpellier. So this school even though under the management of the unmarried clergy who composed its faculty was rising out of the fog of the dark ages and endeavoring to expand to a more modern conception of science. Valesio continued to practice at Montpellier and became one of its pre-eminent men and probably one of the professors at the school for he was appointed later Archdeacon of King Charles VI of France. During the latter part of the fourteenth century, he began to write and published his first book *Tractatus Epidemialis* in 1401. Nothing more came from his pen until he had been thirty six years in practice when he finished his great work *The Philonium*. One of the reasons he wrote the book

was to furnish to the profession a complete practice of medicine because he noted and deplored the paucity of books at this time. Daremberg states that in the preface to an early edition he says "where will one find the hooks of Hermes of Rufus of Andromachus of Paul of Oribasius?" He then goes on to explain that it is his intention to write a complete treatise which will gather all the information contained in these books in one volume, naively adding that it would be free from all errors and then enters into a description of the superstitions of which the *Philonium* is full. He appears to have been greatly impressed with the importance from a superstitious standpoint of the number seven, a belief prevalent at the time. He calls attention to the fact that there are seven cardinal sins, seven spirits, seven petitions in the Pater Noster, seven days in the week, seven planets and many other important sevens. Consequently he divides the *Philonium* into seven books which treat of diseases of the human body in an orderly sequence from the head to the feet.

At a later period the exact date of which is unknown he wrote his smaller treatise *The Surgical Philonium concerning the method of cure of external affections*. In this he discards the head to foot method of division and considers surgical affections from the standpoint of pathology and symptomatology beginning with abscess, phlegmon, erysipelas, carbuncle, etc. and ending with a thirty first chapter which describes hemorrhage from wounds.

Valesio de Taranta was one of the first of the physicians of the late middle ages to attempt to gather the material of the ancients in an accessible form and he succeeded fairly well. His knowledge of the ancient literature was considerable for his quotations from nearly all the early authors of importance are multitudinous. He includes both the ancient Greeks and the Arabians and does not neglect the writers just previous to his own time. It is not at all surprising therefore that when printing came into vogue his work should become popular. It was first printed in 1490 including both the medical and surgical parts preceded by an introduction by Joannes de Tornamira, Chancellor of Montpellier. During the sixteenth century no less than ten editions were necessary to supply the demand. By the time the eighteenth century was well under way however later books had become more popular and Taranta's *Philonium* appeared for its last printing in 1714.







## REVIEWS OF NEW BOOKS

**T**HE book entitled *Robert Jones Birthday Volume*<sup>1</sup> is a collection of surgical essays by various authors. The preface by Sir Berkeley Moynihan is a masterpiece. These papers were written by the closest personal and professional friends of Sir Robert Jones. It is an expression of the high regard which these men maintain toward their friend colleague and in many cases their teacher. Each paper was written by a man who writes with authority on his subject. The papers are clearly written, well illustrated, and the subjects well chosen. The volume is a worthy tribute to the great Sir Robert Jones.

The chapter on the history of orthopedic surgery is interesting. Osgood gives a summary of his opinion on the association of intestinal stasis and spinal and sacro iliac arthritis. Putti describes two cases of tumor of the femur. His operative procedure is ingenious and his points in diagnosis and treatment of bone tumors are valuable. Jansen's discussion of the dissociation of bone growth is very good.

Key Groves' paper on the treatment of congenital dislocation of the hip discusses the open operative reduction. His anatomical considerations are very good. Allison discusses open operations for congenital dislocation of the hip. Elmslie writes on fibrocystic diseases of the bones.

Holland gives a complete exposition of the accessory bones of the foot describing 24 conditions.

The late Clarence Starr summarizes his valuable teachings on acute infections in bone emphasizing the points in diagnosis and the principles of treatment. Mitchell discusses spiral fractures.

Platt treats the subject of nerve disturbances in the elbow region. Fairbank describes 8 types of cervical spondylitis. Aitken discusses curvature of the spine. Bristow's contribution is on the subject of cysts of the semilunar cartilages of the knee. Smith discusses adjuvants on knee joint surgery.

McMurray's paper on the diagnosis of internal derangements of the knee is highly authoritative. Bankart discusses dislocations of the shoulder joint enumerating 7 complications. Calve's classical description of osteochondritis vertebralis infantilis is in French. Wheeler describes bone grafting in Pott's disease. Girdlestone discusses arthrodesis of the hip. Evans writes on astraglectomy. Dunn's discussion on arthrodesis of the tarsus is very valuable. Trethowan discusses fracture dislocation of the ankle and Lynn Thomas contributes an Appreciation. P. L.

fessor Eyster. This is a new and worthy addition to bedside study. It is important enough to warrant widespread attention, and should be read by all internists.

It seems proved that measurement of the venous pressure is an indirect but specific determination of the functional status of the heart, and as such it is an aid in replacing clinical opinion by objective measurement. Certainly the value of arterial pressure measurement is so great that it is hard to imagine doing without it. Doctor Eyster's instrument for measuring venous pressure at the bedside is shown and explained, and the technique of its use is fully given. His observations suggest that venous pressure measurement may be of greater immediate importance in heart failure than arterial blood pressure. But in addition to this practical aspect which is well presented, he makes an exact analysis of circulatory dynamics in heart failure that is fascinating to anyone interested in this most important and common problem. PAUL STARR

**T**HE fourth volume of the *Oxford Monographs on Diagnosis and Treatment*<sup>2</sup> concerns a field in which there is very widespread interest i.e. diseases of the thyroid. It is written, as are the other volumes in this series by men who have personally contributed greatly to the advancement of knowledge in the field covered. The volume is introduced by an interesting historical review of earlier clinical observations. The anatomy and functions of the gland thyroxin a classification of thyroid disorders and a consideration of the use of the metabolic rate are presented in the next chapter. Then follows a general discussion of methods of treatment with an illuminating account of surgical sequelae. The remainder of the work covers colloid goiter exophthalmic goiter, adenomatous goiter and hypothyroid states.

In general this is not a personal critique but an impartial presentation of commonly held views. The material is supported by many references throughout the discussion and a considerable list of titles follows every chapter. Several illustrative cases accompany each clinical problem presented. This volume certainly gives a broad and, at the same time thorough view of modern knowledge of thyroid disease. PAUL STARR

**T**O one who has spent approximately a quarter of a century in the fascination of similar work, this small volume on *The Treatment of Fractures*<sup>3</sup> betrays expressions of disappointment and walls of complaint against the non recognition of the value

A COMPACT monograph<sup>4</sup> on the physiology, technique of measurement and practical importance of venous pressure has been written by Dr

<sup>1</sup> THE ROBERT JONES BIRTHDAY VOLUME: A COLLECTION OF SURGICAL ESSAYS BY VARIOUS AUTHORS. New York and London: Oxford University Press, 1935.

<sup>2</sup> THE CLINICAL ASPECTS OF THYROID DISEASE. By J. A. E. Eyster M.D. M.D. New York: The Macmillan Company, 1939.

<sup>3</sup> THE DIAGNOSIS AND TREATMENT OF DISEASES OF THE THYROID. By J. H. H. Means M.D. and Edward P. Richardson M.D. New York and London: Oxford University Press, 1939.

<sup>4</sup> THE TREATMENT OF FRACTURES. By Lorenz Roehrer M.D. Authorized English edition by M. L. Steinberg M.D. M.D. Vienna: Wilhelm Maudsich, 1939.

of preparedness and efficient care in the treatment of fractures. One wonders why in the analysis of surgical values the study and treatment of fractures are belittled. Certainly the gross mortality, the functional and economic loss and the unhappy influence of these lesions on human life are as great as the other more frequently discussed major causes of death.

This book bears the stamp of individuality. It is divided into two parts: the first covers general remarks on the treatment of fractures; the second covers specific fractures. The discussion on pseudoarthrosis is particularly good. Open operation on recent fracture is frowned upon. For the average reader there is considerable imbalance in the space allotted to the various bones: skull fracture, for example, having a scant two pages.

The author's hobbies are well expounded, namely, local anesthesia for reduction, almost constant use of skeletal traction, zinc gelatin dressing and the application of unpadded plaster-of-Paris dressings to fractured limbs.

On the whole, the translation of the second part is better than the first part. The value of the book lies principally in the illustrations; the expression of one man's experience and in its use as reference for anyone who has watched the author work.

KELLOGG SPEED

THE general scheme of the book on *Diseases of the Larynx*<sup>1</sup> is that of most texts on diseases of the throat. However, it has the added advantage of including diseases of the esophagus and large

<sup>1</sup>DISEASES OF THE LARYNX IN CLINICAL THOSE OF THE TRACHEA, LARGE BRONCHI AND ESOPHAGUS. By HAROLD FARR M. D. (Lond.) F.R.C.S. (E. & G.). New York and London: Oxford University Press, 1929.

bronchi. Endoscopy in its various phases is dealt with exceedingly well for a small text. The illustrations are well done and the latest work on surgery of the larynx is well delineated. The conciseness of the text recommends it for the student.

JOHN F. DELRU

THE third edition of *A Manual of Proctology*<sup>2</sup> by T. Chittenden Hill is practically the same as the previous one. Little new material is added. In the chapter on ulcerative colitis the work of Bargen and Logan is mentioned but the author does not give his experiences with this form of treatment.

The injection method of treatment of internal hemorrhoids is fully described; the different solutions discussed with preference given to the 5 to 10 per cent solution of quinine and urea hydrochloride as originated by Tirrell in 1916. It is plainly pointed out that this form of treatment is unsuitable for external hemorrhoid and the excessively hypertrophied, fibrous internal hemorrhoid.

The chapter on cancer of the rectum has been revised. The selection of suitable cases for operation together with the pre-operative and postoperative treatment is fully discussed. The operation of choice is the one developed by Jones, which is described in all its details and accompanied by numerous illustrations.

Every subject in the field of proctology is treated in a clear and condensed form free from many unnecessary details. It is unquestionably a very valuable book in teaching the subject of proctology.

C. J. DE BEER

<sup>2</sup>A MANUAL OF PROCTOLOGY. By T. Chittenden Hill, Ph.D. M.D. F.A.C.S. Philadelphia: Lea & Febiger, 1929.

## CORRESPONDENCE

### A GENERAL CONSIDERATION OF CESAREAN SECTION

To the Editor: In the June 1929 issue of *Surgery, Gynecology and Obstetrics* in an article entitled "A General Consideration of Cesarean Section," I made the statement that the proportion of abdominal deliveries to vaginal deliveries at Jefferson Hospital was 1 to 6. These figures were quoted from a source which I had every reason to believe accu-

rate and reliable. My attention has since been called to the fact that they are entirely incorrect and that the actual incidence of cesarean section at Jefferson Hospital including all services is only 2.8 per cent.

I would ask that you publish this letter in your correspondence columns in order that the injustice done unwittingly to this excellent institution may as far as possible be rectified. C. JEFF MILLER



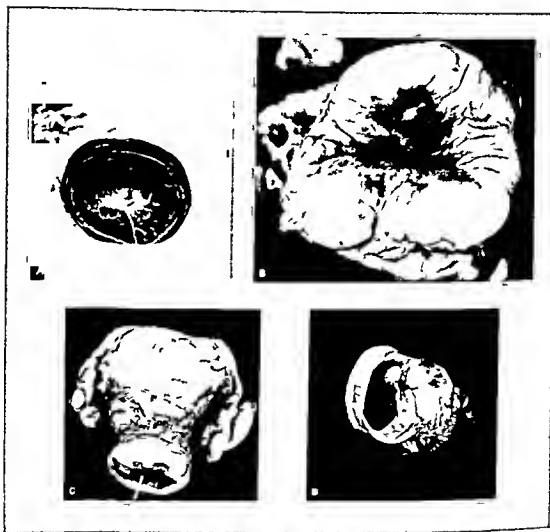


Plate I *A* Nulliparous erosion *B* Gross appearance Stage 2 cervical erosion. *C* True ulceration of cervix *A* generalized ulcerative state involving a hypertrophied and lacerated cervix *D* A discrete ulcerative area situated on the surface of the portio and not involving the external os

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## AN INQUIRY INTO THE BASIC CAUSE AND NATURE OF CERVICAL CANCER

THE PATHOLOGY OF CERVICITIS (EROSION OF THE CERVIX) AND THE RELATION BETWEEN  
CERVICITIS AND CERVICAL CANCER<sup>1</sup>

K. A. BAILEY M.C. M.D. CH.B., MANCHESTER, ENGLAND

### INTRODUCTION

IN this work, I have made a routine examination by histological methods of 850 specimens of the cervix uteri. My object has been two fold (1) to ascertain the precise pathology of so called cervical "erosion" and (2) with a thorough knowledge of this pathology as a basis to inquire into the problem of the inception of cervical cancer. I think that all authorities agree as to the definite relationship between these two conditions, just as they are apt to disagree as to the exact nature of this relationship.

In this country the question of the pathological life story of "erosion" of the cervix has been to some extent neglected. The all important subject of cancer in this situation continually takes precedence. Articles upon the histological features of this latter condition are often bereft of much of their scientific value on account of an associated vagueness in respect of the pathology of an "erosion" present in conjunction.

Although therefore my main endeavor is to elucidate as far as possible the problem of the inception of cancer of the cervix, I have

realized that without a searching investigation into the probable antecedent state, as a preliminary—by which at any rate the pathology of that condition may be thoroughly understood—it would be useless to make this attempt, that is, without having what I consider to be the essential basic knowledge.

To this end, therefore, I have collected this series of specimens—removed for all causes at St Mary's Hospital—and have examined them individually by serial section. By this means the various histological features described in the text have manifested themselves over and over again. The histological appearances and cell reactions described are repeated in this series so many times that their constancy is, in my opinion, irrefutable. The photographs shown are merely the best obtainable of the type.

The construction to be placed upon the behavior of the tissues under the varying conditions, however, remains to be decided, and upon this aspect I dwell, of course, at some length.

This work is, therefore, divided into two parts. Part I deals with a consideration of the pathology of cervical "erosion" to which I have added a discussion of the pathology of ulceration of the cervix, and Part II with the relationship between "erosion" and cancer.

The material from which I have compiled this work has been collected from specimens removed at operation by members of the Honorary Staff of St Mary's Hospital. I wish to record my thanks to them for the facilities they accorded me.

In the preparation of this article I have been assisted by a grant from the Manchester Committee on Cancer.

There is no doubt that a certain histological "no man's land" exists between these two conditions. I have attempted to bridge this by continued and closely applied routine examination throughout this long series of cases. The "precancerous" phases belong to this section, histological appearances which are ever debatable epithelial characteristics which are regarded as "significant" "suspicious" types, and so on. Many of these aspects will be found to be included in the description of what I believe to be conditions far removed from the cancer phase. The distinction between histological appearances of indefinite malignancy has interested me, and I trust that some light may hereby be thrown upon this controversial matter.

This histological "no man's land" does not present itself as a separate entity. It is impossible to deal with it in its order—between discussions of "erosion" and "cancer." Many of its aspects belong to the pathology of "erosion" proper (including ulceration). The problem of the onset of the cancer phase must be approached from a wider standpoint than from the limited investigation of an indefinite interstage. The actual nature of epithelial behavior under all conditions, throughout the life history of "erosion" to that of definitely established cancer, must be elucidated in order inevitably to include this interstage—to take it in the pathological stride.

The epilogue consists in a discussion of certain important features in early but definitely established cancer without in any way encroaching upon the subject of cancer pathology. The object of this work ends as soon as cancer begins. However, the last link is necessary to complete the chain.

#### HISTOLOGICAL NOTE

The histological appearances of the normal cervix uteri have been uniformly described by many authors.

"A fibromuscular structure the portio vaginalis of which is covered by squamous epithelium which merges at the internal os with the high columnar epithelium lining the cervical canal beneath which glands of a compound racemose type are situated in a

stroma closely resembling that of the general fibromuscular wall of the cervix into which it insensibly passes." Such is—in outline—the normal histology generally agreed upon (7).

It is also laid down that the squamous epithelium covering the portio is normally devoid of cellular downgrowths—such as is observed in the squamous epithelium of normal skin—between the papillae. The basal layers of the cervical squamous epithelium, therefore, normally present a fairly even surface to the subepithelial fibromuscular structures immediately in contact.

Erosion of the cervix or the catarrhal patch of Barbour is considered to be a pseudoadenomatous condition and has been classified into the congenital type and the inflammatory type. The subclassification of simple, papillary, and follicular erosions in no way interferes with the general pathology of the condition which in all cases is due to an overgrowth of the cervical lining elements on to the portio (displacing the epithelium of the affected area) on account of a glandular and epithelial hyperplasia secondary to an infection which is evidenced by a round cell infiltration in the immediate vicinity.

Watson (8) says that the commonest cause of erosion is laceration of the cervix resulting from childbirth. Wilson (8) also says that in many cases of erosion of the cervix there are no signs of inflammation present, histologically, and the appearances suggest that the usual covering of the vaginal portion of the cervix has simply been replaced by one continuous with, and similar to, that which normally lines the cervical canal.

He remarks: "It is at least probable that among the manifold changes consequent upon the formation and healing of erosions, some may ultimately be discerned that definitely predispose to the occurrence of cancer that represent in fact precancerous conditions comparable to those found in certain other situations."

Bonney states that in all cases of early cervical cancer examined by him, there was evidence of erosion and cervicitis and that the precarcinomatous state is one of chronic inflammation characterized by the presence



Fig 1 A nulliparous erosion associated with a mild inflammatory reaction



Fig 2 Stage 1 Histological appearance of an inflammatory erosion

of lymphocytes and plasma cells in the subperitoneal tissue, together with the disappearance of elastin and collagen and with epithelial hypertrophy.

Wilson concludes that the exact relation between the precarcinomatous state and the inception of cancer still calls for elucidation, it may be, of course, that the one condition passes immediately into the other or even that the precarcinomatous condition is already malignant, on the other hand it is probable that the real precarcinomatous condition is one that merely prepares the ground so to speak, in which the cancer seeds are enabled to germinate, or, further, it is conceivable that the condition represents the first attempt of the body to protect itself against cancer that is already implanted or is in process of evolution.

Gilbert Strachan says "the lesion is essentially inflammatory and when first seen the inflammation is usually chronic in type. According to varying estimates it is present in greater or lesser degree in 75 to 80 per cent of parous women and in about 25 per cent of nullipare." The slight degree of erosion seen in virgins is due to a persistence of the fetal conditions in the cervix where the gland bearing columnar epithelium is not confined to the cervical canal but extends partly on to the portio producing a red area around the external os. However, in other cases of erosion in nullipare and virgins, Strachan considers the causal factor to be an infectious one consequent upon the lowering of the

normal acidity of the vaginal secretion in conditions of anæmia and general ill health. In nulliparous non virgins and some parous women, gonorrhœa is the cause of infection.

In most cases a greater or lesser degree of cervical laceration is present, but it is to be recognized that the extent of the subsequent erosion bears no relationship to the degree of laceration. A very small laceration may be followed by extensive erosion and vice versa. It is the virulence of the infecting organisms that counts.

In speaking of the process of infection, Strachan says "The subepithelial tissues become hyperæmic and œdematous, with redness and swelling of the cervical mucosa. This is accompanied by an increase of the excretion from the cervical glands, which appears clinically as a mucoid or mucopurulent secretion to which the general name of leucorrhœa is given. As a result of the epithelial infiltration a certain number of the squamous epithelial cells surrounding the external os are raised from their bed and finally cast off, thus leaving a red raw circle around the os. This raw area becomes covered by columnar epithelium which has been stimulated to grow out from the cervical canal. Racemose glands are carried out along with the epithelium and may proliferate greatly, producing the condition described by Eden as pseudo adenoma, and usually called an 'erosion'."

He later says "Many authorities stress the point that this so called erosion does not







Fig. 1 A nulliparous erosion associated with a mild inflammatory reaction



Fig. 2 Stage 1 Histological appearance of an inflammatory erosion

of lymphocytes and plasma cells in the subepithelial tissue, together with the disappearance of elastin and collagen and with epithelial hypertrophy

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Fig 3 Stage 1 Inflammatory erosion a somewhat farther advanced state

represent an ulcer," and that the red strawberry appearance is due to the deeper inflamed tissues being seen through the columnar epithelium. But parts normally covered by columnar epithelium—the uterine cavity or cervical canal—do not present this red appearance. Again, a more or less dense infiltration of lymphocytes is always found below the surface indicating the presence of a chronic infection and this would hardly persist if the surface were completely covered over. Further, there is in every section examined an area between the columnar covering on the one side and the squamous on the other where there is no surface epithelium and where the condition represents essentially a chronic granulating area.

Strachan says "the most important sequel of erosion is undoubtedly carcinoma. The continued irritation of the epithelium of the damaged mucosa would appear to be a predisposing factor in the production of epithelioma of the cervix. This condition usually occurs in a parous woman who is likely to be the subject of cervical erosion, in many cases the transition from the one condition to the other can be traced both clinically and histologically and there is little doubt but that erosion is the main predisposing factor in the production of carcinoma of the cervix.

Carey Culbertson of Chicago recently contributed a paper to the *Journal of the American Medical Association* in which he reviewed the subject of cervical erosion. He concludes

that the sequence consists of (1) infection with resultant inflammation and (2) leucorrhœa and papillary erosion. Erosion of the follicular type, he says, is really an additional process, usually ascribed to attempts at spontaneous healing.

Culbertson's discussion of the part played by leucorrhœa in the production of erosion is interesting. He says "That erosion is the direct result of a more or less continuing excessive discharge is undoubtedly. One practically never sees an erosion in the absence of a vaginal discharge, and its presence is evidence that there is an excessive cervical secretion whether the patient complains of it or not. But such an explanation is not, in itself sufficient. There are profuse discharges in which erosion is not seen. Thus, the lesion is not common in the virgin with retroversion uteri or descensus uteri and leucorrhœa, nor is it seen to develop in the occasionally profuse discharge occurring in pregnancy. In certain leucorrhœas, in other words, the flat epithelial cells of the portio are preserved. In others these cells macerate and disappear thus giving the cylindric mucus secreting cell opportunity to proliferate and start the formation of the simple erosion. There must be some other factor in addition to the presence of the leucorrhœa itself, or, what is more probable, certain changes must take place in the nature of the discharge in order to produce erosion."

It will be seen from this that although Culbertson acknowledges the effect of leucorrhœa itself upon the production of erosion, he does not consider the question of the relative irritative qualities of leucorrhœal discharges in this respect.

In discussing the precancerous nature of various erosions Culbertson quotes Stone who applied the term 'pre cancerous' to those changes which show a variable quantity and quality of the other histological criteria of cancer. Culbertson however considers that atypical healing in the follicular type of erosion produces changes often differentiated with difficulty from the alterations typifying malignant disease. In this connection he shows photomicrographs exhibiting such conditions as the plugging of distended gland



Fig 4. Low and high power photomicrographs Stage 2 Cervical erosion so called papillary erosion. The first

attempts at repair on the part of columnar epithelial elements Proliferation in the presence of irritation

spaces by squamous epithelial cells, extensive and massive round cell infiltration with disintegration on the surface, and describes as definitely malignant sections of tissue showing diffuse thickening of the surface epithelium with relatively short irregular downgrowths from the basal layers. Of course I should like to see the actual sections in these cases—but even without these I am sure that I have many similar sections in my own series and, as I hope to describe later this appearance does not suggest itself to me as malignant, but as the result of healing in the presence of irritation—the irritation slowly diminishing allowing the healing to complete itself. The type of cell is too adult the irregularity of basal growth too uniform and too simple to suggest to me the presence of that influence which is at the basis of all malignancy.

In 1925 Philip J. Reel discussed the relationship between cervical erosion and cancer.

He says "For all practical purposes the frequency of cancer of the cervix in the virgin is negligible. Here, of course, the cervix has not been tormented by the presence of old lacerations scar tissue formation or, as in some instances, even a low grade infection, but, on the other hand, it is highly probable that a certain percentage of these have endured the irritation of the congenital types of erosion over a considerable period of time."

It seems to me, in connection with the above,

that Reel rather stretches a point in speaking of the "irritation" of congenital erosion. The erosion in these cases, according to observers is due to a purely anomalous position of the cervical lining, not to chronic irritation. Reel reiterates the well known fact that cancer of the cervix is by far most prevalent in those women who have borne children and in whom are found to a greater or lesser degree the results thereof, namely, laceration scar tissue, erosion, and secondary infection.

C. H. Mayo says "the part played by chronic irritation in the development of cancer is positive and definite to a degree. The danger of cancer is increased by all irritation and traumatism which demands a continued cell repair, and it is in proportion to that demand. Ultimately exhaustion of cell control bodies occurs modified by age limitations and chemical surroundings. Such areas offer an increasing opportunity for the ball of a dividing cell to revert to the unicellular type of life and to become parasitic and cancerous."

Reel attributes the irritative nature of "congenital" erosions to the action of the acid secretions of the vagina upon the misplaced epithelial lining with "consequent secondary infection" which is more virulent in a situation of this nature on account of the fact that such misplaced tissue does not possess the normal degree of immunity.



Fig. 5. A somewhat more advanced picture of Stage 2. The glandular downgrowths have penetrated deeply and show more proliferation of pre-existing cervical glands and less inflammatory reactions. No glandular distention. Small areas of more flattened surface epithelium are shown.



Fig. 6. Stage 3. New squamous epithelium is beginning to replace the columnar epithelium. There is rarefaction of the denser tissues. Deep glandular elements are apparent but little distention is as yet evident.

Reel attaches importance to the exposure of cervical membranes to acid media such as occurs in eversion of the cervical lips—in the production of erosion.

Reel agrees with Eden and Lockyer in preferring the term 'proliferative adenoma of the cervix' to erosion on account of the gross appearance suggesting tissue gain rather than loss. He discusses purely the relation between erosion and cancer and like other observers assumes that all erosions are in effect precancerous states and that treatment—whether medical or surgical—should be immediately carried out on diagnosis. Facilities should be such as to render this practicable as early as possible. Reel like other authors dealing with cervical erosion—even when its association with cancer forms part of the problem—accepts or agrees with the pathology of erosion as expressed by others—as a type of proliferative adenoma, papillary, adenomatous or follicular according to local histological conditions—a redundant area of proliferated cervical lining—lying on the surface of a corresponding area of the portio which has been stripped of its superficial epithelium by chronic inflammation.

This is, of course, a well recognized condition, but one which I think does not play such an important part in the production of cancer as, what I call, a "true ulcerative" type of erosion, a condition to which the

name "erosion" can well be given in that there is definite tissue loss, the erosion area lying at a deeper level than the epithelium of the portio. The actual glandular and columnar cell proliferation in these cases is relatively small and the penetration of the irritant relatively great as compared with proliferative erosions.

Findley again lays great stress upon the treatment of the "precancerous states," namely erosions and eversions of the cervix and endocervicitis as the best means to combat the onset of cancer. He remarks that there seems to be no consensus of opinion as to what constitutes precancerous lesions of the cervix and he quotes the opposed views of such pathologists as Schottlaender and Rick in their interpretation of the various cell changes observed by them. Again Frank asserts that these 'radical pathologists classify as beginning cancer conditions which lacking as we do absolute histological criteria of early malignancy, may as well prove to be harmless epithelial proliferation.'

However, Findley does say 'while recognizing the occurrence of epidermization as a benign lesion I would regard extensive changes of this sort as the precursor of cancer. In all cases where great irregularity in cell form and size, atypical mitosis and hyperchromatism are found the diagnosis of malignancy is established.'

I think that Moench discusses the question of cervical erosion with great lucidity. In definitely differentiating between the pathology of the various cervical conditions which are at present known as "erosions," he draws clear distinctions between them.

His chief conclusions are as follows:

1 The so called congenital erosion due to an anomaly of growth should be called congenital pseudo erosion.

2 The term "endocervicitis" should be replaced by the term "cervicitis" as corresponding more nearly to the morphology present.

3 The inflammatory erosion of the cervix has a stage of actual true erosion and three stages of healing in which it is covered, first, by no epithelium at all, then by columnar epithelium, and in the last two stages by squamous cell epithelium.

4 An ectropion may be due to marked, especially acute, inflammation, or may be due to laceration and eversion of the cervical lips.

Moench thus differentiates definitely between inflammatory erosion and the other conditions such as ectropion, eversion, and congenital erosion, which are loosely called erosions.

From a study of my cases, I am completely in accord with Moench in these distinctions and also in his description of the pathology of inflammatory erosion. This condition however, as Moench describes it, fulfills my conception of proliferative inflammatory erosion according to my classification.

In his description of inflammatory erosion Moench considers that the "rather unstable balance between the columnar and squamous cell epithelium" in the region of the external os due to the epithelial changes which occur embryologically at this point has a marked influence upon the frequency of inflammatory cervical erosion. I agree with him as to the derivation of the primary covering of columnar cell epithelium over the eroded area in that it originates by direct extension from the cervical canal epithelium or from some of the superficially lying cervical glands "which easily can, and do, reach the surface of the portio"—and not, as Ruge and Veit

believed, as an extension from the basal cell layer of the squamous cell epithelium. In speaking of the last stage of healing in which the squamous epithelium completely covers the erstwhile eroded area, Moench quotes Meyer in saying "In this way squamous epithelial downgrowths occur which to the inexperienced, may give the impression of malignancy." This is in entire agreement with my own observations and substantiates my belief that it is from the actual type of cell which is concerned in atypical distributions of epithelium that the diagnosis of malignant activity is to be made. As I shall point out later, the process of healing by epithelium in the presence of continued irritation cannot show other than atypical formations.

With regard to the recurrence of cancer in the cervix, the difficulty is recognized of definitely being able to state the actual site of commencement in the great majority of cases.

For instance, the endocervical type, which predominates, may have its origin either in the basal layers of the squamous epithelium covering the portio or in the columnar epithelium of the cervical canal, and it is nearly always impossible to observe from which of these elements any given cancer has sprung.

Wilson (8) says "That Cancer takes its origin in intimate relations in space with pre-existing epithelium is certain, but that its inception is due to a 'metaphasia of the normal epithelium' has not been proved." He also asserts that there is present a distinct line of demarcation between the normal surface epithelium covering the cervix and any squamous epithelioma in connection with it. There is no histological proof, he says, of a gradual transition between the one and the other. He, however, admits the occurrence of epithelial downgrowths in the vicinity of the malignant tumor, but regards this as due to irritation. Wilson even remarks "It, therefore, appears better to drop the term squamous epithelioma, which implies development from the epithelium covering a definite part of the cervix, and to speak of solid alveolar carcinoma of the cervix."

Bonney has stated that the external os is implicated in every case of cervical cancer, but Wilson says that only 50 per cent of his early cases began at the external os.

In reviewing cancer statistics, B P Watson points out that in 1922 and 1923, cancer of the uterus accounted for 16.5 per cent of all deaths in females from cancer in England. The percentage of deaths from cancer of the breast slightly exceeds this figure. He says "In attempting to diminish the incidence we must not be discouraged by the fact that we do not yet know the ultimate cause of cancer. There are many diseases such as malaria, sleeping sickness, and yellow fever, the incidence of which was diminished before their ultimate cause was known, simply by controlling one factor which appeared to play a part in their causation. The nature of all the agencies which have to work together before cancer can develop in the uterus we do not know, but one condition—namely, irritation—is so constant in cancer of the cervix that it must be recognized as one of the etiological factors."

"Frankl's statistics show that 97 per cent of all cancers of the cervix occur in women who have borne children. The number of pregnancies and labors plays a secondary role. The fact that a woman has had one child predisposes her to cancer of the cervix; that predisposition is almost certainly due to injury of the cervix. If that injury is followed by chronic infection and catarrh as is so frequently the case after deep lacerations, the predisposition is increased. We know that cervical catarrh occurs in nulliparous women as the result of infection and even in virgins in whom infection can be excluded, and these may be the nulliparæ who develop cancer."

Watson, therefore, stresses the importance of the surgical treatment of cervical laceration and inflammatory states of the cervix in the firm belief that the incidence of cancer would be diminished thereby.

Statistics all over the world agree upon this point of multiparity as a predisposing cause to cancer. Leipmann reports that cervical carcinoma in nulliparæ was found by Kroemer to occur in only 1.77 per cent of

cases, by Koblauch in 4.6 per cent, and by Theilhaber and Edelberger in 2.9 per cent.

Cullen also collected 50 cases of squamous cell carcinoma of the cervix and found that 49 of these had borne children and that half the patients were mothers of 5 or more children. Cullen also states that Howard A. Kelly has seen only 3 nulliparæ who had carcinoma of the cervix, and in 1 of the 2 an instrumental dilatation had been previously performed. Cullen, therefore, believes that trauma by instrumental dilatation of the cervix is a possible factor in the development of carcinoma of the cervix.

In this connection Lillian K. P. Farrar investigated the period of time after the last pregnancy at which cancer of the cervix developed, and in her series found this to occur in less than 5 years in 11.1 per cent, between 5 and 10 years in 9.2 per cent, between 10 and 20 years in 41.7 per cent, between 20 and 30 years in 24.4 per cent, and she concludes that repeated injury in successive pregnancies is a point of significance as a predisposing factor. In fact Dr Farrar considers that cervical lacerations are themselves directly responsible for the onset of cancer and in common with other authors advocates the routine repair of the cervix either by primary or secondary operation.

With regard to these views, I consider that one cannot legitimately dogmatize upon the fact of cervical laceration being the predisposing cause of cancer without first demonstrating that cancer originates in or near, the laceration, and this of course is not the case. Although the vast majority of cancer cases in a series show cervical lacerations following childbirth, I consider that this particular injury is of such common occurrence, in fact almost of necessity occurs in greater or lesser degree in association with parturition that failing this pathological proof of cancer incidence the significance of the constant presence of old lacerations in cervical cancer might conceivably be much less than some authors aver. A laceration is an apparent injury and as such perhaps is blamed in excess of its deserts.

The specific nature of cancer growth has exercised the minds of many authors in the

past Ewing in America, Schottlaender in Germany, and Blair Bell in this country are well known authorities

Blair Bell looks at the central problem of cancer from as wide a standpoint as possible and regards it as comprising "a complete understanding and control of that divergence from the normal, both from preventive and curative points of view" and not "as a quest after the so called cause or causes of cancer" He seeks after the "specific process" rather than the specific cause and regards malignant neoplasia as a specific process in itself, but not necessarily due to a specific factor Blair Bell is skeptical in regard to the idea that a single specific causal agent or a combination of two specific causal agents or factors is inevitably responsible for malignant neoplasia, as suggested by the work of Gye on account of the fact that the majority of investigators agree that such factors are numerous and together establish the conditions necessary for the development of cancer In his work, therefore, he has concentrated upon a consideration of the *nature of cancer* as a specific process rather than an investigation into the character of the exciting stimuli

In studying the theories of Blair Bell and Gye in respect of cancer growth, however, I have often thought that, whereas Gye strives to elucidate the mystery of a causal agent at the one end of the scale, and Blair Bell extracts the very essence of the growth process at the other, the intermediate fact of a possible specific influence affected maybe by the former thus resulting in the production of the latter has been overlooked

Blair Bell says that malignant neoplasia arise from cells of impaired function, 'unhealthy cells,' and that whatever causal factor whether metabolic or extrinsic, can permanently impair a cell, without killing it, may be regarded as a predisposing cause or 'exciting factor' of malignant development

He moreover asserts that phosphatides and other lipins are present in larger quantities in malignant growths than in normal somatic tissues Gye and Cramer (4) showed in rat tumors that the phosphatide content

varied as the rapidity of the growth, and shows by experiment that the cells of malignant neoplasia possess a higher water content, a higher phosphatide value, and a higher phosphatide cholesterol ratio than either normal tissue cells or innocent tumor cells, and approximate in these respects to the cells of the chorionic epithelia which are themselves "normal malignant" cells or cells of restrained malignancy Permeability of the cell membrane is favorable to rapid growth and is an essential to malignancy This property is associated with a high phosphatide cholesterol ratio and a high water content is evidence of it

In this research, Blair Bell has aimed at discovering the essential difference in type between the normal and malignant cell and has made use of the cells of the chorionic epithelium, normally present during development of the fetus, but normally possessing functions without parallel in other cells of the human body and demanding characteristics definitely associated with malignancy in adult tissues, as we understand it, and moreover assuming a supermalignant activity on the loss of that control, an understanding of which would mean so much in the elucidation of the cancer problem

Blair Bell further found that the metal lead had an affinity for the phosphatides and cholesterol contained in cell protoplasm and that its action upon the normal chorion epithelium was a specific one, a coagulation necrosis being brought about within the cells His lead treatment for cancer, therefore, is based upon these experiments, the direct aim being to cause an arrest and destruction of the growth by inducing necrosis of its cells or combining the lead with their phosphatide contents

Blair Bell thus defines malignant neoplasia as "a specific growth process in that it is a reversion on the part of the starving cell to the nutriment seeking proclivities of its ancestral type, the chorionic epithelium"

Recently W Schiller has discussed the diagnosis of very early carcinoma of the cervix He is satisfied that just as in the later stages a superficial extension may precede deep penetration of the neoplasm at



right angles to the epithelial covering, so in the very earliest stages the neoplastic change, which (he asserts) invariably commences near the external os proceeds centrifugally along the surface of the cervix.

In a series of 135 cases in which the uterus was removed for other reasons, Schiller found that early evidence of carcinoma occurred in 4.

Schiller defines the pathological cytology as "anaplastic atypia and polymorphism" of the epithelial cells. He says that in the very earliest stages the epithelium is as definitely marked off from the underlying connective tissue as in normal conditions, but both in the basal and superjacent layers neighboring epithelial cells and their nuclei are of differing size and shape, with variable staining properties. The nuclei are relatively more numerous than in the healthy epithelium, from which the early carcinomatous area is marked off by a sharp and unusually oblique line of demarcation.

Neither absence of mitoses nor absence of penetration of the epithelium deep into the connective tissue excludes the diagnosis of carcinoma. Inflammatory infiltration beneath the carcinomatous zone is usually noted.

Thus certain of Schiller's findings are in agreement with my own. For instance, I am sure that the beginning of carcinoma occurs in the region of the external os. The cell changes in early carcinoma are similar to those observed in my series. As to the "oblique line of demarcation" between the carcinomatous and unaffected areas, I am not wholly in agreement as to this being of a purely pathological nature.

More recently still, at the International Cancer Conference certain distinguished speakers discussed the latest theories as to the etiology of cancer.

James Ewing favored the irritation theory. He said "It seemed clear that cancer arose only on tissue which had become altered by chronic irritation." He declared that there was no one exciting cause of cancer, nor one great secret in the cancer cells.

Archibald Leitch discussed certain specific irritants which appeared to be able to produce cancer under certain conditions and in certain hosts.

J. B. Murphy dealt a severe blow to the virus theory of cancer. He asserted that fractional precipitation of the proteins from extracts of the Rous chicken sarcoma results in the production of a purified fraction which is capable of reproducing tumors in fowls. This active fraction had also been isolated from tissue of normal fowls free from contact with tumor-bearing animals, a fact which negates the specific virus theory. Murphy, therefore, considered that one had to deal with endogenous chemical substances rather than with extrinsic living viruses.

J. McIntosh on the other hand considered that the virus theory had been regarded too lightly.

A. Borrel also supported the virus theory. Many other speakers of international repute contributed to the discussion which, however, terminated in a stalemate between the biological and parasitic theories—a position which has so long prevailed. Experimental cancer production has not yet reached the stage of consistency. The unknown "agent" has not yet been elucidated. Production of cancer by the direct injection of the specific agent presumed to be present in certain extracts, or by the indirect method of irritation by chemical irritants, has not yet resulted in any one fact being common to all. The adherents of both the great etiological theories therefore are still able to stand firmly by their separate and distinctive views.

## I THE PATHOLOGY OF CERVICITIS—EROSION OF THE CERVIX

Much has been written concerning the pathology of cervical erosion, much, that is, by American and Continental authors. In this country, however, gynecologists and pathologists have tended to evade this subject. I can find little evidence in British journals of a systematic inquiry having been carried out in respect of it. B. P. Watson's account, as published in Eden and Lockyer, (8) is a standard description.

My series of 850 specimens of the cervix uteri removed for all causes, including that of cancer, contains 822 instances of cervical erosion in its various phases and a study of these has led me to adopt definite views as to the pathology of these phases. In the main I am in agreement with certain American observers but I feel that a wide enough view has not been taken in respect of certain factors in the life history of this condition.

## CONGENITAL EROSION

The reddened patch observed to envelope the external os in the nulliparous and presumably non-infected cervix has been long accepted as being due to an anomalous growth of the mucous membrane lining the cervical canal whereby it fails to recede during infancy from its encroachment on to the portio.

I have not verified or disproved this view myself but I can assert that cases of this type in my series show definite evidence of an associated inflammatory reaction which presumably then would be of a secondary nature. Whether this reaction is due to the effects of bacterial infection or chemical irritation one cannot say. In any case this fact has no important bearing upon our view of the pathology of erosion—the basic factor concerned being in all cases, a typical acute, subacute or chronic inflammatory infiltration in contact with the affected area. I therefore prefer to use the word *irritation* in place of *infection* throughout as a term which embraces the effects of either bacterial or chemical contact.

Moreover the type known as congenital erosion is by comparison relatively rare and

is consequently, from the point of view of this work, of much less importance as a precursor of cancer than the great group of inflammatory erosions with which I am about to deal.

Histologically there is no reason to distinguish between this type and the proliferative erosion which is brought about as the result of irritation. The inflammatory reaction is there or has been there. Whether it is the cause of the lesion, or secondary to it, depends upon one's acceptance of the etiological theory.

Plate 1 A The gross appearance of the nulliparous erosions. This is taken from a case in which there were 2 or 3 small uterine fibroids present in the uterus. Panhysterectomy was performed in a nullipara. Such specimens are, of course, difficult to obtain, as removal of the cervix is not a recognized form of treatment for erosion in the nullipara, and panhysterectomy is also as a rule infrequently performed in these patients.

Figure 1 shows the histological appearance in this case and demonstrates the evidence of an old inflammatory reaction in association.

## INFLAMMATORY EROSION

The so-called erosion proper or inflammatory erosion of Moench has long been a recognized pathological and clinical entity. American rather than British observers have studied this most important subject of gynecological pathology. A study of my cases which exhibit instances of this condition has led me to agree to a large extent with these observers. I have studied the subject of cervical erosion as a preliminary to, and as part and parcel of, my inquiry into its relationship to cancer of this situation and I propose to deal briefly with its various phases as I believe they occur.

STAGE I THE PRIMARY EFFECTS OF IRRITATION  
(A TEMPORARY PHASE OF TRUE EROSION)

The irritant during the first stage is acute or subacute and is evidenced by the presence of a localized reddened patch of affected surface tissue near the external os.

Microscopically it is observed that the squamous epithelium of the portio has had no time to react to the inflammatory irritant. There are no hypertrophic downgrowths of it or other associated proliferations of its cells which occur as its specific reaction to the more chronic irritations. Instead the epithelium is stripped off bodily at the level of its lowermost layer of cells and lifted up by the invasion of masses of large and small blood cells and others composing the exudate excited by the inflammatory reaction. The glandular elements situated in the region of the external os have also no time as yet to proliferate so that the affected area of the portio is characterized by a comparatively thin layer of inflammatory material—which has itself not yet had time to penetrate the muscular tissues of the cervix to any appreciable extent—bounded by a strip of partially desquamated but otherwise normal squamous epithelial covering, which is continuous at its further end with as yet unaffected epithelium on the one side and the glandular elements near the internal os on the other.

I found that cases in the early stage were the most difficult from which to obtain a specimen on account of the fact that the condition had progressed to chronicity as a rule before the patient came to operation, that is for removal of the cervix. Patients exhibiting early cervical irritation, *per se*, are of course treated by other means, so that I possess in my series only 8 cases which show this early stage at all well histologically.

Figure 2 shows the histological appearance presented in the early stage.

Figure 3 shows a slightly farther advanced degree of the same stage. Here the irritant goes somewhat deeper and there is a commencing activity on the part of the cervical glands to react by proliferation. As yet, however, the surface irritation predominates and there is no attempt to recover the affected area by new epithelium.

I consider that during this first stage only, one might justly term the condition erosion. There is actual loss of surface epithelium now with no replacement. There is a replacement of the firm surface muscle tissues by semiliquid inflammatory material. The af-

ected area is truly eroded. But this stage is a relatively temporary one as compared with the long standing stages of chronicity which follow, and which themselves are known, erroneously in my opinion, as variations in type of cervical erosion. On the other hand, this early and temporary stage which is pathologically a true erosion is generally termed acute cervicitis which of course is a correct nomenclature.

#### STAGE 2. EPITHELIAL REACTION TO INFLAMMATORY IRRITATION, PROLIFERATION AND REPAIR

The second stage marks the limit of the inflammatory ascendancy—the moment at which its advance is checked by the epithelial defending elements.

The evidences of the inflammatory reaction are definitely lessened. The surface exudate is less, although it still contains a number of leucocytes, and it is intimately associated with the new surface epithelial covering which is identical with, and derived from, the columnar epithelium lining the cervical canal and cervical glands. The affected cervix now presents the typical appearance associated with this condition. A roughly circular area around the external os is reddened and slightly raised above the level of the portio. This area is soft and "velvety" to the touch and may bleed on examination. It is caused by a true redundancy of abnormally situated columnar epithelial elements in association with the products of a subsiding inflammatory reaction.

Microscopically it is observed that the products of inflammation are much lessened and are now intermingled with a new surface covering composed of a single layer of high columnar epithelial cells from which glandular downgrowths into the subjacent rarefied areas have taken place. The epithelium lining the cervical canal has responded to the inflammatory irritant and has proliferated in an effort to repair at the same time exercising its specific function in the manufacture of new glandular elements. These downgrowths vary in depth, and between them the sparse connective tissues of the

inflamed cervical surface persist in varying amount. This gives the appearance of small, papillary projections with central connective tissue cores and has resulted in the term "papillary erosion" being applied to this state. At this stage then the new surface elements do not penetrate the underlying muscle to any extent—the depth of the erosion along most of its extent being only that of a single short glandular downgrowth. In the region near the external os, however, where the normally situated cervical glands are placed, the depth increases somewhat owing to a localized proliferation of the actual glands themselves, whereby they spread outward and upward to the surface at its nearest point. As yet, however, even the more deeply situated of these glands have not had time to enlarge by distention and the epithelium lining all these new downgrowths remains of the high columnar type. The general appearance of this stage is one of great epithelial activity in the presence of a continued but less virulent irritation (Fig 4).

A battle is now waged between the invading inflammatory elements and the defensive epithelial tissues, until a stage is reached at which the glandular downgrowths have reached their furthest penetrative limit and the inflammatory reaction has considerably lessened in activity. Absorption of some of the older exudative material is beginning to take place with consequent rarefaction of the basic surface tissues. Here and there small thin strips of a flattened epithelium can be discovered on the very surface of the affected area. There is however, no glandular distention among the new elements all of which communicate freely with the surface. The pre-existing cervical glands in the region of the external os have reacted to the irritant to their utmost extent and have proliferated as far as possible to merge gradually into the new glandular formations. This is the turning point between destruction and repair, and is characterized by the obvious lack of necessity for further epithelial activity, the irritant being now inefficient to effect this phenomenon. Figure 5 shows an example of this end phase of Stage 2.

### STAGE 3 REPLACEMENT OF COLUMNAR BY SQUAMOUS EPITHELIUM ON THE SURFACE OF THE AFFECTED AREA COMMENCEMENT OF FINAL REPAIR

This stage is one of immense interest histologically in that it exhibits a range of variations in accordance with the conditions under which it takes place. The recovering of the affected surface by squamous epithelial cells—cells which are much less resistant to maceration than columnar epithelial cells—can take place to perfection only in the complete absence of irritation. Many of the variations shown in the development of this stage are due to the different degrees of irritation still present at the time of healing. Others are due to recurrence of the irritation in greater or lesser degree, as the result of re-irritation, after healing has partially taken place and others are again the outcome of regenerative growth in non-resistant areas. A cursory glance at certain of these variations, especially if one is not accustomed to the study of gynecological pathology, will undoubtedly result in an erroneous impression being conveyed as to the innocence or otherwise of the epithelial growth as here depicted. The general histological picture presented by this stage is one of gradual encroachment on the part of a highly sensitive epithelium in its purpose of covering an area still smarting from the recent attack by a severe irritant, which has been checked by proliferation of columnar epithelium.

This epithelial encroachment is made as the result of new cells growing from the basal layer of the nearest unaffected squamous covering upward toward the adjacent columnar epithelial surface and lifting this simple layer up in lever fashion, thereby gradually replacing it. The new squamous covering at this stage is only two or three cells in thickness but proliferation is seen to take place as the advance proceeds until the actual growing edge may assume almost a normal thickness of say 20 cells. In parts also the columnar epithelium becomes overrun and the new squamous cells encroach partially or wholly into the glandular downgrowths.

It is a noticeably constant feature of this stage that the tissues immediately beneath

the columnar epithelial elements are greatly rarefied. This is due to the absorption of the products of inflammation which have occupied this area up to this time. Here and there, however, one may discern isolated subepithelial situations which are still under the influence of the inflammatory irritant. These are not covered by new squamous cells. The growing edge proliferates actively from its basal layers on approaching such a situation and ends as a bulbous mass exhibiting cellular downgrowths of varying extent according to the degree of irritation experienced. The gradual, cautious, and timid advance of these cells is well exemplified in the early stages of their repair work. Only where the ground is safe will they venture. Their proliferation by cell division, with the formation of a more rounded, almost hexagonal type of cell possessing a deeper staining nucleus and cytoplasm—altogether a less stable type of cell—in situations that have relatively little effect upon the columnar epithelial elements, is remarkable (Fig 6).

To recapitulate then the salient histological features of this stage are (1) the irregular, relatively thin strips of new squamous epithelium on the affected surface encroaching on to the area covered by columnar epithelium, (2) the rarefaction of the denser subepithelial tissues, (3) the almost total disappearance of inflammatory reaction, and (4) the relatively deep penetration of the glandular downgrowths which, however, show little or no dilatation as yet.

Figure 7 also shows this stage. The glands here have penetrated deeply a fact from which one may gauge the age of the condition. The superficial areas are rarefied, but although new squamous epithelium has appeared on the surface there is no dilatation of the lumina of the glands. It will be noticed that here there is practically no evidence of irritation. The new squamous epithelium has been able to effect its work of resurfacing the portio without interference. There have not even been any temporary difficulties to overcome in this respect, as is evinced by the absence of cellular downgrowths from the deeper layers of this new covering.

Now with regard to Stage 3, one often

observes that this initial attempt to heal is thwarted as the result of surface infection being locally too irritant to admit of new squamous cell encroachment. It is obvious that the attempt to recover the portio by new squamous epithelium is begun as soon as the irritability of the causal agent has dropped to a certain degree in the neighborhood of unaffected squamous epithelium, compatible with the ascendancy of new cells which would emanate from it. As I have before explained, this level is of necessity very low as the new squamous cells are unable to tolerate the effects of irritation in any amount without proliferative activity. The growing edge of the new epithelium therefore, often encounters a point at which the surface irritation is still too active to tolerate its presence, with the result that further advance is prevented and the furthermost cells of the new epithelial covering proliferate into a bulbous end in response to the irritation experienced on approaching the vicinity of this area, this notwithstanding the fact that new columnar epithelium proliferated from the old cervical lining is in actual contact with the inflammatory zone, engaged in fighting down its destructive effects. Here is a proof of the relative stability of columnar epithelium as compared with the squamous type of this region. The further advance of the new squamous cells is prevented until subsidence of the irritation has reached the necessary point for tolerance.

#### STAGE 4 THE STAGE OF ULTIMATE HEALING

The fourth stage is that at which complete ascendancy has been gained over the surface tissues by the new epithelial covering. From what I have just said it will be realized that this phase may not be completed without some temporary setbacks being experienced by this epithelium. We therefore see many cases in which ultimate success has been won in the process of healing at the expense of localized proliferative downgrowths of these cells. Occasionally one may even still observe the fading effects of localized irritative obstacles in the association of scattered infiltrative areas connected with the basal cells of these downgrowths.

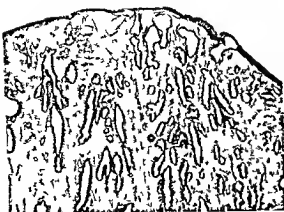


Fig. 7 Stage 3 slightly more advanced. New surface epithelium with greater continuity but relatively thin keratinization of surface tissues. Deep glandular penetration. Great diminution of inflammatory reaction. Little dilatation of glands.

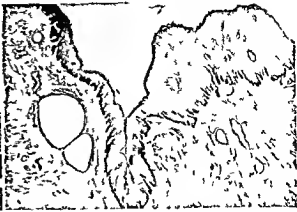


Fig. 8 Stage 4. Ultimate healing has taken place in the presence of localized irritation which is due to isolated irritative foci. There are epithelial downgrowths from the deeper layers. Dilatation of glands beneath epithelium.

This phenomenon of healing in the presence of irritation is extremely interesting histologically and accounts for numerous appearances resulting from cell behaviors which have a bearing upon the cancer problem.

It is sufficient at this moment, however to exemplify my meaning by referring to Figure 8 which shows this aspect of Stage 4. It will be seen that the new epithelium exhibits isolated downgrowths as the result of proliferation of the cells of its deeper layers—a responsive reaction to the experience of an irritant of low degree.

Irritations, or low grade infections, such as these, however are as a rule not sufficient permanently to stay the advance of the healing cells relatively simple as this is, and in many cases the only evidence that such a temporary difficulty has occurred at all is the presence of one or more cellular downgrowths from an otherwise evenly based squamous covering.

In Figure 8 one may observe the difficulty experienced by the new squamous epithelium in performing its function, but it has obviously succeeded in this, notwithstanding the continued presence of some irritant probably of an infective nature. At one point the squamous cells have had recourse to proliferation resulting in a marked increase in the number of layers of cells. In this situation the chronic irritation is still evi-

denced by a round cell infiltration in association with the deepest layers of the epithelial cells from which it is also plain that the proliferation originates.

In this section there are irregular cellular downgrowths along the whole length of the epithelial covering, and it is everywhere noticeable that the deepest and most active are in association with areas of scattered round cell infiltration, an irritation of poor degree but sufficient to call for the reactive changes in these new cells.

This stage is characterized by the presence of dilated gland spaces situated beneath the new covering, the result of mechanical blocking of their ducts by the squamous cells. Here and there the new cells can be seen to have grown wholly or partially down into the lumen of glandular structures opening freely on to the surface.

The histological appearances presented by Stage 4 may therefore differ in a variety of minor ways according to the type of cellular reaction present.

In some cases complete healing has obviously taken place with no difficulty on the part of the new epithelium. The primary infection has apparently subsided evenly and quickly. This is evinced by a uniform and relatively thin layer of squamous cells covering the old erosion area, which now appears as a mass of scattered glandular structures,

the columnar epithelial elements are greatly rarefied. This is due to the absorption of the products of inflammation which have occupied this area up to this time. Here and there, however, one may discern isolated subepithelial situations which are still under the influence of the inflammatory irritant. These are not covered by new squamous cells. The growing edge proliferates actively from its basal layers on approaching such a situation and ends as a bulbous mass exhibiting cellular downgrowths of varying extent according to the degree of irritation experienced. The gradual, cautious, and timid advance of these cells is well exemplified in the early stages of their repair work. Only where the ground is safe will they venture. Their proliferation by cell division with the formation of a more rounded, almost hexagonal type of cell possessing a deeper staining nucleus and cytoplasm—altogether a less stable type of cell—in situations that have relatively little effect upon the columnar epithelial elements, is remarkable (Fig 6).

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Fig. 11 left A discrete chronic ulcer of the cervix  
Note that the demarcation is very definite  
Fig. 12 Retrogression of ulcerative activity Shallow

granulation area—no penetration Blunt epithelial down growths containing a large percentage of old cells. Commencing proliferation of cervical glandular elements

erosion and distinct pathologically though linked clinically with the erosions hitherto discussed

Ulceration of the cervix may not completely involve the region of the external os. Indeed in some instances this area is not affected at all, the ulcer in these cases remaining discrete and located to the surface epithelium of the portio

Plate 1 D shows this type of ulceration

It is rare however to find the external os completely free from involvement, but readily understandable that this virulent form of irritation may be occasionally detected in this phase before extension from a primary focus on the portio has taken place sufficiently to envelope it

My series shows instances of this ulcerative erosion and I have remarked it as a relatively common condition in association with the damaged and hypertrophied cervix usually removed during the operation for uterine prolapse

The salient features of the gross aspect of this condition, which definitely differentiate it from proliferative erosions, are (1) the depressed nature of the affected area, (2) the overhanging epithelial edges in immediate contact, and (3) the smooth granular surface coated with chronic exudative material

Histologically this state presents a very characteristic appearance. The surface of the affected area is entirely denuded of epithelium

and is composed of a mass of granulation tissue exhibiting varying degrees of organization. The actual surface elements are relatively dense and penetrate to approximately the depth of normal epithelium. A highly hemorrhagic zone lies immediately beneath the surface granulation and below this the tissues are infiltrated to varying depths by masses of lymphocytes, leucocytes, and macerated epithelial cells, according to the degree of activity of the irritant present. The causative agent is obviously of such a virulence as absolutely to negative any attempt at healing on the part of the adjacent epithelium. Even the glandular elements of the cervical canal are unable to encroach within this area. Epithelial tissue is unable to exist in association with this virulent and deeply destructive irritant

In the early stages of proliferative erosion we saw the rapid and wholesale destruction of the surface epithelium, followed by healing as the patient's resistance successfully combated the attack. Here it is apparent that the process is a more continued one the irritation continuing to chronicity, with failure of the healing process. The areas adjacent to the normal epithelium contain masses of half destroyed and macerated squamous cells. However, in active ulceration there is no subsidence on the part of the irritant, no rarefaction of the subjacent tissues due to absorption of inflammatory



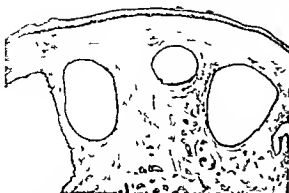


Fig 9 Stage 4 A healed erosion Healing on the part of new squamous epithelium with no difficulty in the absence of surface irritation

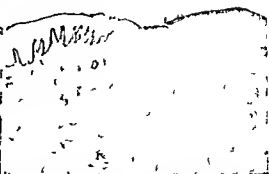


Fig 10 Ulcerative erosion involving the external os A depressed granular area Irritative epithelial downgrowths

varying in degrees of dilatation and situated at varying depths below the surface amongst rarefied tissues

Figure 9 shows this appearance well This is the state commonly known as a healed erosion Here the process has been relatively simple The irritant responsible for the primary erosion has subsided and only minute traces remain The new squamous cells have been able to perform their function without molestation There are no proliferative downgrowths either into the subjacent tissues or into the surface glands, the ducts of which, however, have nevertheless been efficiently occluded by means of the thin overgrowths of cells

In describing the histological characters of cervical erosion as they have appeared to me in studying my series of cases, I have propounded little that is at variance in any way with the accepted views of this condition The authors indicated in my historical note record appearances very similar to those that I have described

I have, however, studied this question, not as a finite state in itself, but as an important preliminary aspect of the development of cancer in this situation As I have said elsewhere, I believe the cervix uteri to be the organ of the body in which the study of cancer growth can best be investigated, and as a means to this end I have preferred to carry out a systematic inquiry into the pathology of a condition which all must recognize as a precursor of that state

In the process of this investigation I have, of necessity acquired certain views upon the condition of cervical erosion which I will summarize in due course Of these views however, I must now indicate one in order to complete this description It is to the effect that I believe a condition of *ulcerative erosion* or *true erosion* to be pathologically akin to the erosion already described and therefore to be a condition which should be classified together with its allied state

This condition is entirely distinct pathologically from that just described It nevertheless constitutes an erosion a true erosion, of the cervix and is commonly met with clinically The type of cervix seen to be chiefly affected is the hypertrophied lacerated, and cicatricial one of the multipara Such a cervix is often observed to be the seat of a chronic ulcerative condition whereby the affected area becomes definitely depressed below the level of the surrounding epithelium of the portio This ulceration may or may not involve the area of the external os but most frequently does

The gross appearance reveals an irregularly outlined depressed, and granular area smooth and discolored to a reddish yellow by the surface exudates partly or wholly involving the portio in the region of the external os which itself is usually heavily distorted by lacerations and scars

Plate 1, C, indicates the gross appearances of this erosion which appears even to the naked eye, as a destructive lesion, a true

Figure 13 shows an old dormant ulcer allowing itself to be healed by a single layer of columnar cells which have appeared on its surface. These have undoubtedly emanated from cervical epithelium which has proliferated to the vicinity.

By this time, however, there is definite loss of tissue so that a completely healed ulcer is essentially a depressed scar.

Ulcerative erosion differs only from the proliferative type in that the primary destructive agent is of greater virulence that is relative to the patient's powers of resistance. Whereas in the one case the invader is rapidly expelled and healing is effected without appreciable loss of tissue, in the other the process is delayed at the price of tissue loss. Epithelium in the vicinity reacting to irritation while being inadequate to cope with the prolonged attack. The lesion produced, ulcerative or proliferative erosion, varies directly as the relative strength of the irritant or inversely as the degree of resistance of the patient to it. In this may only can a localized irritation attain to chronicity. The lesions are therefore essentially the same from an etiological standpoint and should be classified on the same pathological basis.

#### SUMMARY

In this part of my work I have attempted to describe in some detail the pathology of so called erosion of the cervix. As I have said elsewhere my object in doing this has been to elucidate a subject in all its phases, which is recognized to be a definite stepping stone in the production of cancer. I consider that it is only by tracing the life history of erosion step by step that one may acquire the necessary knowledge of associated cellular changes that is essential in the study of its all important sequel. To this end therefore I have extracted the necessary details from my series of 850 specimens which have gone to the formation of I fear, a somewhat prolonged and labored dissertation.

In summarizing this part of my subject I am unable to resist joining with many previous authors in an attack upon the old nomenclature. The term 'erosion' is an entirely erroneous one in this connection from

the pathological standpoint. This term was primarily applied as a facile description of the gross appearance of certain aspects of the condition only, purely a clinical nickname instituted in the days when the science of morbid anatomy, as applied to gynecology was by no means as advanced as it is today, and in any case, as a clinical term contrary to the laws of medical terminology today, founded as it is upon a pathological basis. The pathology of this condition determines its etiology from an infective or irritative source and of these two I have no doubt that the former is a correct assumption. In either case however, a typical inflammatory reaction of some degree is always in association and therefore the term *cervicitis* is the only applicable one.

Now we know that infection limited to the cervical glands results in an appearance differing from that under discussion, hence necessitating a distinct nomenclature. Also Moench definitely states the congenital origin of certain erosions seen in the virgin and assigns to them the term *congenital pseudo erosion*. In this connection I would say that cases of this type in which one could definitely dissociate the element of infection histologically must be very rare. In my series I have only 3 specimens of the virgin cervix in which there can be no question of infection. A definite erosion is not present in any. However, I do not dispute the view held by Moench. My own is that this class is a very minor one.

I would therefore, assert that the correct nomenclature in the group of cases hitherto known as proliferative erosion is *peri or ular cervicitis*, that the ulcerative erosion which I have described should be termed *ulcerative cervicitis*, and that infection limited to the cervical glands is properly termed *glandular cervicitis*.

Broadly speaking, this lesion (erosion) is produced by the effect of the inflammatory reaction, locally applied in the region of the external cervical os, for varying lengths of time, and the reaction of the involved tissues to it. A temporary attack, or one the virulence of which is quickly combated by the patient's resistance results in a temporary



Fig. 13 Commencing healing of old ulcer. A single short layer of columnar cells on the surface of the ulcer

exudates, no healing. The only cellular reaction discernible, and this is so constant as to be typical, consists of a series of irritative downgrowths from the deeper layers of the adjacent surface epithelium. This is due to the spread of the irritant beneath the surface of the epithelium radially from the central focus and its continued action upon the adjacent epithelial cells. Lymphocytic and leucocytic infiltration can be seen in contact with these epithelial downgrowths which, of course, are totally inadequate from a healing point of view, but as one would expect represent on the part of the highly sensitive basal cells of the squamous layer a typical reaction to chronic irritation. Indeed, partial or total destruction of many of these cells takes place concurrent with proliferation. This fact can be observed in the scattered masses of disintegrated squamous cells lying in intimate contact with the proliferative downgrowths in cases in which the virulence of the infection continues.

An ulcerative erosion therefore may be recognized histologically by its salient features which are (1) a depressed granular area extending deeply into the subjacent tissues presenting a relatively dense structure and containing no epithelial structures and (2) associated with a highly irritative type of adjacent squamous epithelium due to ineffective proliferative downgrowths from the basal layers.

Figure 10 shows ulcerative erosion involv-

ing the external os and demonstrates the type of adjacent epithelium found in association with this condition.

In these cases in which the ulcerative state is localized to the portio, the demarcation is very definite, the depressed nature of the lesion is very obvious and the chronicity well marked.

Figure 11 shows an example of this class of discrete ulcer, of which of course there may be various sizes and shapes.

By an "active ulcer," I mean an ulcer which is the site of an irritation which is continuous in such virulence as to bring about increasing loss of normal tissue while presenting all the histological characteristics of acute irritation. In such a case there is nowhere any evidence of subsidence on the part of the causative agent. This, however, does eventually occur in certain cases, but in the type of patient whose resistance is such as to tolerate ulceration or may be on account of the extreme virulence of the agent concerned the retrogressive process is necessarily slow. One does however observe the more chronic less active type of ulcer which presents the appearance associated with gradual absorption of the old inflammatory products and cessation of penetration.

Figure 12 demonstrates this type well. Here the virulence of the causal agent is lessened to a point at which the patient's resistance can effect a cure by healing. In such a case one sees that the exudates are confined much more to the surface and that a rarefied zone lies immediately beneath, indicative of absorption of the erstwhile penetrative elements. Moreover the adjacent squamous epithelium is unaffected by immediate leucocytic infiltration, the subepithelial tissues being again rarefied and the cellular downgrowths being now blunter at their points and containing a large percentage of older cells.

At a later stage when the irritant has been slowly overcome and the ulcer has become more or less dormant, one may observe the first attempts to repair the wounded surface. This is as usual undertaken by columnar epithelium, a further proof of the resistant nature of this type of cell.

ANNULAR PANCREAS<sup>1</sup>

NELSON J HOWARD M D SAN FRANCISCO CALIFORNIA

THE term "annular pancreas" is applied to a developmental anomaly in which a firm ring of pancreatic tissue completely encircles the first part of the descending portion of the duodenum. It has a clinical as well as a morphological significance.

Becourt in 1830 first recorded this anomaly. Moyses, Ecker, Tiedeman, and Auberg have described the condition, Ecker being the first to apply the name ring or annular pancreas to the unusual finding. Symington, Generisch, Thieken, Thatcher, and Summa have also contributed to our knowledge of the structure and anatomical relations of the annular pancreas, and its embryological development has been studied by Baldwin, Lecco, and Cordes.

At an early period in the human embryo, two outgrowths develop from the alimentary canal, one projecting dorsally in the dorsal mesentery and the other arising in common with the choledochus ventral to the primitive alimentary canal. This ventral pancreatic anlage has two offshoots, a right and a left, although the latter soon disappears. Through the rotation of the duodenum about its axis the dorsal and the ventral anlagen approach each other and fuse, so that they lie behind and to the left of the duodenum.

The dorsal anlage develops to form the body and tail of the pancreas which lies transversely in the abdomen behind the stomach, while the ventral anlage grows to become the caudal part of the head of the pancreas which is enclosed within the duodenal loop. At the fusion of the dorsal and ventral anlagen an anastomosis between the ducts of the two portions of the embryonic pancreas occurs, and although the ventral anlage forms eventually only a small part of the gland, the duct of the ventral anlage becomes the main pancreatic duct or duct of Wirsung, while the duct of the dorsal anlage becomes the accessory pancreatic duct of Santorini (Fig 2).

It was Thieken who first suggested "If the ventral and dorsal anlage of the pancreas did not unite as they ordinarily do, but each developed independently, there would be pancreatic tissue on either side of the intestine, and, as growth proceeded, the bowel would soon be completely surrounded by glandular tissue." Shortly thereafter, Baldwin described a specimen of adult human pancreas showing non fusion of the primitive dorsal and ventral anlagen of the pancreas, together with an insufficient rotation of the ventral anlage around the duodenum. He was fortunate also, while studying a series of adult human pancreas, in discovering one specimen of annular pancreas. In a careful study of this case of annular pancreas he found in the head of the pancreas the beginning of a duct which formed no connection with the accessory pancreatic duct but which coursed from left to right with increasing caliber ventrally through the ring of pancreatic tissue surrounding the duodenum to the head of the gland posteriorly, where it passed dorsal to the common bile duct and opened into the main pancreatic duct. This fact indicated to him that the ring of pancreas encircling the duodenum was a persistence of the left half of the ventral anlage or an excessive growth of the right half of the same anlage.

In a most precise and exhausting study of two specimens of annular pancreas, Lecco utilized the embryological development of the pancreatic ducts to determine the mode of origin of the annular pancreas. According to Lecco the annular pancreas differs from the normal gland in possessing a portion which arises from the dorsal portion of the head of the adult pancreas and encircles the duodenum. The arrangement of the ducts of the annular pancreas is similar to that of the normal pancreas, and the smaller variations of arrangement occurring in the annular pancreas find a parallel in almost identical variations in the normal pancreatic ducts (Fig 3).

<sup>1</sup>From the Department of Surgery Stanford University Medical School

primary destructive phase (Stage 1), which represents a true erosion of the normal surface, followed by epithelial reactive activities progressing to healing (Stages 2, 3, 4, 5). An attack of greater virulence or one of which is relatively weakly combated by the patient's powers of resistance results in a prolonged battle between the invasive element and the involved tissues. The resistance is slow. The virulence of the invader is but slowly overcome. Loss of tissue combined with penetration of the irritant is concurrent with organization of the exudates and the attenuation of the causal agent. A state of chronicity exists, which is represented by a typical appearance and is attended by typical epithelial reactions, ulceration. This state that of ulceration represents true erosion of the normal tissue surface, as also does the temporary Stage 1 of the proliferative type. These two conditions then might truly be spoken of as erosions if necessary, although the term from a scientific point of view remains crude.

I will have failed in my purpose if I have been unable to convey the impression of histological accuracy in the discussion of this subject just concluded. It has been toward a thorough understanding of the tissue reactions concerned in cervical erosion that I have concentrated in my study of this condition, and to that end I have preferred to trace its histological life history step by step. At this stage therefore the various aspects of erosion in all its phases, its degrees, its associated cellular activities (which I shall speak of later), its histological eccentricities almost are now understood as the result of this routine examination. The ultimate sequel to erosion is malignancy, but there is the phase between these two which must be

bridged—the pre malignant phase which must contain the primary malignant reactions. In this work I have aimed at the recognition beyond doubt of these earliest manifestations of cancerous change, in the hope that some light may thereby be thrown upon the origin of this disease.

#### REFERENCES

1. BELL W. BLAIR. The specific character of malignant neoplasia. *Lancet* 1915 Nov. 1003.
2. BELL W. BLAIR. HENDRY R. A. and ANNETT H. E. *J. Obst. & Gynaec. Brit. Emp.* 1915, XLIII, 1.
3. BONNEY. *Lancet* 1908, 1, 1350.
4. BULLOCK (Gye.) W. E. and CRAWER W. *Proc. Roy. Soc.* 1913 p. 230.
5. CYLBERTSON C. Erosion of the cervix uteri with observations on its causes, development and result. *J. Am. M. Ass.* 1926 Nov. 27.
6. CULLEN T. S. Cancer of the Uterus. 1909 pp. 63 and 174.
7. EDEN and LOCKYER. *Gynaecology* 1910.
8. Idem. *New System of Gynaecology* vol. II.
9. EWING JAMES. *Neoplastic Disease* 1919.
10. FARRAR LILLIAN K. P. The reaction of the tissues to radium in the treatment of cancer of the cervix and the importance of lacerations in produced cancer in this location. *Surg. Gynec. & Obst.* 1926 XLIII, 719.
11. FINDLEY PALMER. Precancerous lesions of the uterus. *Am. J. Obst. & Gynec.* 1926 II, 450.
12. GYE W. E. The aetiology of malignant new growths. *Lancet* 1925 July 109.
13. International Cancer Conference. *Brit. M. Ass.* 1928 July 21, 105.
14. LIEPMANN. *Handbuch der Frauenheilkunde* vol. II p. 79.
15. MAYO C. H. *J. Canadian M. Ass.* 1918 VII, 86.
16. MEYER R. *Zentralbl. f. Geburtsh. u. Gynaek.* 1910, 440.
17. MOENCH G. L. Cervicitis erosion and laceration of the cervix uteri from the standpoint of pathology. *Am. J. Obst. & Gynec.* 1926 II, 453.
18. REEL PHILIP J. The danger of cervical erosion. *Am. J. Obst. & Gynec.* 1925 V, 94.
19. RICE. *Ztschr. f. Gynaek.* II, V, VIII. *Zentralbl. f. Gynaek.* 1881.
20. SCHILLER W. *Arch. f. Gynaek.* 1928 Feb. 23, 211.
21. SCHOTTLAENDER. *Monatschr. f. Geburtsh. u. Gynaek.* 1911.
22. STRACHAN GILBERT I. *Brit. M. J.* 1925 Oct. 24, 43.
23. VETZ. *Ztschr. f. Gynaek.* XUI. *Ergebn. Geburtsh. u. Gynaek.* 1910. *Deutsche med. Wchnschr.* 1911.
24. WATSON B. P. *Brit. M. J.* 1925 Aug. 15, 279.

bile stained material and peristaltic waves in the stomach were visible through the lax abdominal wall. There was no jaundice. A diagnosis of congenital pyloric stenosis was made, but at operation the stomach and pylorus were found to be normal. Beyond the pylorus the duodenum was continued as a thin white cord having the size and appearance of a goose quill which could be rolled under one's finger, and which penetrated a hard irregular tumor that proved to be the head of the pancreas. The tail and body of the pancreas were normal in size and consistency. Below the pancreatic head the duodenum quickly regained its normal appearance. Because of the atresia of the duodenum a posterior gastro-enterostomy was done. The child had an uninterrupted convalescence.

**CASE 2.** Reported by Reynoldo Dos Santos. A young woman 26 years of age had suffered from stomach trouble since the age of ten. At that time epigastric pain after meals with occasional vomiting and pyrosis was noticed. The pain was often relieved by eating. During the last 2 years of her illness, the pain and vomiting had become more frequent and retention of food was present, the vomitus occasionally containing food taken several days previously. Frequent hæmatemesis and tarry stools appeared and the pain became so severe that even water was not tolerated. A diagnosis of duodenal or pyloric stenosis with ulceration was made, and at operation a posterior gastro-enterostomy was performed. The patient improved rapidly and was eating a soft diet when bilateral pneumonia caused her death on the ninth day after the operation. An autopsy revealed two ulcers on the posterior wall of the stomach which was greatly dilated and a duodenum which was completely modified in its relations. The first portion ascended to the head of the pancreas where it was fixed by a ring of pancreatic tissue, which constricted the duodenum to a diameter of 1.5 centimeters. From the postero-inferior portion of the pancreatic head there arose a prolongation of the gland 1 centimeter thick which completely encircled the duodenum. The entire pancreas was distinctly lobulated and hard to palpation and a microscopic section showed a chronic interstitial pancreatitis. The gall bladder and ducts were normal.

**CASE 3.** Benedetti reports an interesting case of annular pancreas in an Italian soldier who died with symptoms of acute intestinal obstruction which had developed in the course of severe sepsis due to shrapnel wounds. At autopsy the obstruction was found to be due to compression of the duodenum by a ring of pancreatic tissue which was swollen and edematous. The stomach was so dilated that its greater curvature descended three fingers breadths below the umbilicus. It was filled with fluid which could not be forced through the duodenum but on releasing the pancreatic ring the stomach emptied readily into the small bowel. Benedetti mentions that Lerat in a case of high intestinal obstruction made a pre-operative diagnosis of annular pancreas

and at operation this was found to have caused sudden obstruction due to acute inflammatory changes in the pancreas.

These 3 previously reported cases which came to surgical intervention were operated upon because of symptoms of acute intestinal obstruction. The case we wish to record, Case 4, manifested the symptoms of chronic duodenal ileus or obstruction as described by Higgins and by Wilkie.

A female aged 46 years, single was admitted to Lane Hospital, April 21, 1928 complaining of abdominal pain of 2 weeks' duration. The patient's past history revealed that in April 1922 she had been admitted to the Stanford Clinic with a complaint of continuous headache and pressure upon the top of her head severe enough to cause insomnia. These symptoms had been present since May, 1921. Her teeth had been extracted and a nasal operation had been performed at another clinic without benefit. No history of nausea or vomiting was obtained at that time but the patient stated that her stomach was easily upset by unpleasant sights or odors. Her appetite had always been very poor and she did not enjoy eating.

A physical examination revealed no unusual findings. During the examination the patient stated she often felt a dragging sensation in the left lower abdomen. She was found to have a refractive visual error which was corrected by glasses. Wassermann reaction was negative. A spinal puncture revealed no abnormal findings in the cerebrospinal fluid. Her basal metabolic rate was at the low limit of normal. Following an examination of the nose and throat, in which there was found crusting in the ethmoid region and a marked discharge of purulent material from the posterior nasopharynx, a tonsillectomy re-opening of the ethmoid cells and washing of both antra were performed but without relief. Six injections of autogenous vaccines made from nasal washings were ineffectual in relieving her symptoms. In 1923, the patient was given a series of treatments with ovarian extract without benefit.

The patient returned to the Stanford Clinic April 20 1928 with an entirely new complaint namely that of an acute pain in the right lower quadrant of the abdomen of 2 weeks duration, not related to eating, defecation or menstruation. The pain varied in intensity from sharp to dull did not radiate and was localized 2 inches to the right of the midline and 2 inches below the umbilicus. Temperature on admission was 37.2 degrees C pulse 80 respiration 20 and blood pressure 130 systolic, 86 diastolic. The head neck and chest appeared normal on examination. The abdomen was moderately distended, with no muscle spasm but with the definite area of tenderness noted above. No masses could be felt and the liver spleen and kidneys could not be palpated. Vaginal examination

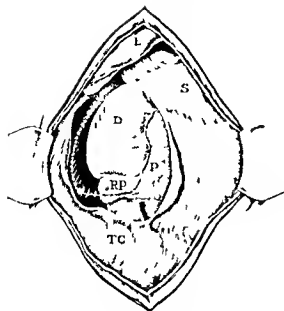


FIG. 1. Annular pancreas, author's case. The peritoneum has been stripped away the transverse colon pushed down to expose the second portion of the duodenum and the constricting annular pancreas. During the operation the patient strained under light anesthesia causing the stomach and duodenum to fill with air and the dilated proximal duodenum ballooned out to the right producing the diverticulum which is shown in the gastric roentgenogram. S Stomach L liver D duodenum P pancreas RP annular pancreas TC transverse colon Dotted line extent of diverticulum.

Lecco shows in his illustrations that the annular pancreas owes its origin to an anomaly of the ventral pancreatic anlage (Figs 4 and 5). Elizabeth Cordes described a case of annular pancreas that differed from those previously cited by having no communication between the branches of the ducts of Wirsung and Santorini both of which opened by separate ampullæ into the duodenum. She also concluded that the annular pancreas arose as an abnormality of development of the ventral pancreatic anlage (Fig. 6).

Anomalies of development have decided clinical interest particularly when they interfere with normal function. Of 11 cases of annular pancreas which were accurately described or in which careful drawings were published, 10 showed a constriction of the duodenum at the level of the pancreatic ring. In the remaining case, described by Cordes

there was a small duodenal diverticulum on the medial side of the duodenum between the orifices of the common bile duct and the duct of Santorini. In one case, that of an infant 3 days old there was atresia of the duodenum. The duodenum was dilated above the ring in 9 cases while in 3 specimens there was dilatation below the ring as well, a phenomenon which calls to mind the dilatation of an artery beyond a partial constriction. The stomach was moderately or markedly dilated in 4 cases and the pylorus was hypertrophied. Three cases presented pathological changes in the parenchyma of the pancreas which was definitely hard and indurated in 2 instances due to an interstitial pancreatitis, and in the other there was an acute pancreatitis secondary to a generalized sepsis. One patient was found to have two ulcers on the posterior wall of the hugely dilated stomach.

One case was unusual in that the ampulla of Vater opened 5 centimeters below the constricting ring. In 20 reported cases jaundice and interference with biliary outflow was lacking. Of the 20 reported cases 16 were first noted at autopsy or during anatomical dissection and no clinical history is available except in the report of Thielen. His patient suffered from cardiac disease and the history indicated that there had been no gastric symptoms in spite of a hugely distended duodenum and stomach as disclosed at autopsy.

The cases of annular pancreas which were operated upon manifested symptoms of high acute intestinal obstruction or of pyloric occlusion and showed strikingly the variable extent of the constriction. In one instance acute symptoms occurred immediately after birth while in the remaining cases gastro-intestinal disturbances were in abeyance from 10 to 47 years before the gradual dilatation and hypertrophy of the duodenum and stomach above the constriction or acute inflammatory changes in the pancreas itself resulted in marked disturbances of the function of the gastro-intestinal tract.

**CASE 1.** Reported by Vidal. A child of 3 days had vomited since birth. Meconium had been passed and the abdomen was not distended but attempts at feeding provoked almost immediate vomiting of

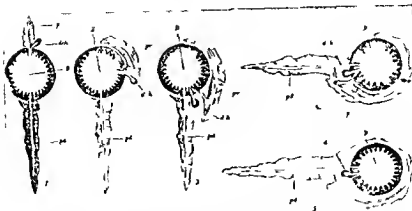


Fig. 4. This shows the mode of development of the annular pancreas. The ventral pancreatic anlage becomes fixed at its free end and during its subsequent migration with the rotation of the duodenum the ventral anlage is drawn out and with the fusion of the two anlagen the pancreas comes to surround the duodenum (After Lecco)

the upper border of the pancreatic tissue and encircled the duodenum. The pancreatic tissue was narrowed to an isthmus about 3 centimeters broad at the lateral anterior wall of the duodenum. At this point a small vein left the vein described above and ran downward across the isthmus. Above the ring of pancreatic tissue the duodenum was fully 6 centimeters in diameter, while below the ring it was narrowed to a diameter of about 4 centimeters. The duodenum was exposed down to the inferior angle of the descending portion of the duodenum and no further abnormality was made out. The duodenum was mobilized so that the ring of pancreas could be seen running laterally and posteriorly gradually enlarging from the isthmus till it joined the head of the pancreas posteriorly and enlarging also as it ran to the left anteriorly to join the head and body of the pancreas. The common bile duct was not dilated and it was carefully palpated so that its position in relation to this anomaly could be fully appreciated. As the patient strained under the anesthetic the duodenum distended above the pancreatic ring and overlapped the constriction anteriorly and to the right thus forming the diverticulum seen in the roentgenogram (Fig. 1).

The pancreatic tissue at the isthmus was freed from the underlying duodenum the vein clamped doubly and the isthmus incised. A duct 2 or 3 millimeters in diameter which ran through the tissue of the isthmus was divided. Several cubic centimeters of clear slightly green colored fluid was obtained. This later became entirely clear colorless and issued from the right end of the incised duct. A probe passed to the right upward and backward could be felt posterior to the common bile duct and duodenum. When passed to the left anteriorly it could be felt as far as the pylorus in an upward and backward direction. The isthmus was cut across a small artery running posterior to the duct was clamped

and tied, and the pancreatic tissue gently freed from the duodenum by blunt dissection. This released the constriction in the duodenum, so that full two fingers could be inserted into the lumen of the bowel by invagination. The divided ends of the duct were ligated and the stumps of pancreatic tissue covered with peritoneal folds. The appendix was found to be fibrous and white and was removed. The pelvic organs were normal except for a small cyst in the right ovary.

The postoperative course was characterized by frequent vomiting of bile stained material, abdominal pain tenderness, and distention fever, and rapid pulse. On the fourteenth postoperative day the patient's pulse increased to 140, her temperature was 38.2 degrees C, respiration, 24, blood pressure, 144 systolic 88 diastolic. The white blood cells numbered 18,750, 81 per cent of which were polymorphonuclears. The direct Van den Berg reaction was positive in 6 minutes the indirect was three units positive and the icterus index was 16.6. Her skin and saliva had an icteric yellowish tinge. The blood chlorides totalled 400.13 milligrams per 100 cubic centimeters. The stool showed many moderate sized fat droplets and urobilin was present.

On examination of the abdomen there was felt for the first time a tender mass in the right upper quadrant and epigastrium which did not move with respiration, and was dull to percussion. The patient was in constant pain, markedly emaciated and dehydrated from frequent vomiting in spite of hypodermoclysis and fluid by rectum.

When the incision was reopened free fluid was found in the abdominal cavity. The fluid was clear and contained no fibrin. Reaching from the liver edge to the level of the umbilicus was a firm mass enveloped in omentum. When the omentum was separated a large amount of slightly yellow turbid fluid was evacuated. After all the fluid was aspirated



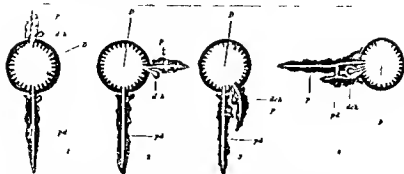


Fig 2 The ventral pancreatic anlage *p v* migrates toward the dorsal pancreatic anlage *p d*, to fuse and enclose between them the ductus choledochus *dch*. The ducts of the ventral and dorsal anlagen anastomose as can be seen in the last figure. Duodenum *D*. (After Lecco)

was negative. The red blood cells numbered 3,600,000, hemoglobin, 80 per cent (Sahli); white blood cells 8,600, with a normal differential count. The urine examination was negative. Gastric analysis with the alcoholic test meal showed a free hydro-

chloric acid of 10 per cent and a total acidity of 31 per cent at the highest reading. The stomach contents varied in color from a slaty grey to a blue grey and contained a great deal of mucus. The stool examination was negative. A roentgenogram of the gastro intestinal tract showed what appeared to be a diverticulum in the second portion of the duodenum.

The patient was transferred to the outpatient clinic for observation and treatment and given tincture of belladonna with some improvement. On May 9 she reported that she had an acute pain in the right upper quadrant and had vomited bile stained material five or six times. A roentgenogram of the gall bladder after the administration of colloidal tetraiodophthalein by mouth showed a normal gall bladder. She was admitted to the Surgical Service May 17, 1928, with physical findings and laboratory tests as noted above.

The patient was operated upon May 22, 1928, by Dr. Emile Holman. Through a right rectus incision the omentum was seen to run upward and to the right around the lateral border of the liver where it was adherent to the posterior abdominal wall. Dense adhesions between the gall bladder and omentum obscured the first part of the duodenum. These were gently separated and the gall bladder was seen to be moderately enlarged, the overlying peritoneum thickened and grey white in color but no stones were palpable. Releasing the adhesions to the lower border of the liver permitted palpation of the right kidney which was very freely movable with nodular apparently fetal lobulations. The pylorus and pyloric end of the stomach appeared normal. By separating the adhesions and the layers of the gastrocolic omentum from the first and upper portion of the second part of the duodenum no diverticulum could be found. Continuing the separation farther on the second portion of the duodenum and releasing it from its peritoneal coverings the duodenum appeared dilated, flabby and bluish in color. The head of the pancreas completely encircled the duodenum at the midpoint of the second portion of the duodenum. A large vein ran along

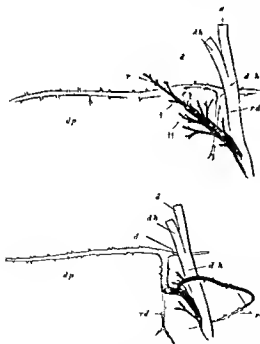


Fig 3 The upper figure illustrates the arrangement of ducts of the normal adult pancreas and their relationship to the ductus choledochus *dch*. The lower figure shows the arrangement of the ducts of the annular pancreas and their morphological identity to the corresponding parts of the upper figure. The lower horizontal duct shaded in black surrounds the duodenum. Both figures are viewed from behind. (After Lecco)

ligated, and the stump covered with pancreatic tissue and with peritoneum, with as little trauma as possible. Nevertheless, these precautions did not prevent the escape of pancreatic fluid and the formation of a pseudocyst with walls formed by the abdominal viscera and omentum, with a severe peritoneal irritation as shown by constant pain, tenderness, fever, very rapid pulse, and leucocytosis. This inflammatory process was evidently of a chemical nature as cultures of the fluid were negative. The absence of fat necrosis at the second operation is most interesting, doubly so since experiments with the fluid showed that it possessed active power to digest fat.

The pancreatic fistula through the stab wound of the second operation discharged an amazing amount of clear, odorless fluid as the patient's bed clothing was saturated with the fluid in spite of frequent changing of drain pads by the nurses. At the rate of 12 drops per minute from the catheter in the wound, as recorded in the progress notes, at least 1,100 cubic centimeters of fluid was lost a day, and to one seeing the seepage from the wound and the constant moisture of the dressing, this is a conservative estimate. The protection of the skin was found to be simple. Zinc oxide applied thick and warm, sprinkled with kaolin, was sufficient to prevent skin excoriation. Undoubtedly, the absence of intense skin ulceration was due to the absence of duodenal secretions, which activates the pancreatic trypsinogen. Trypsin activity was present in the fluid, however, as digestive tests showed complete digestion of 5 cubic centimeters of 1 per cent casein by 0.4 cubic centimeters of pancreatic fistula fluid in one-half hour at 37 degrees C. The amount and character of the fluid discharged warrants the assumption that the major portion of the pancreatic secretion escaped from the fistula by retrograde flow through the cut end of the duct and in the annular portion of the pancreas. It has been shown by Lecco that this duct is a main branch of the duct of Wirsung in the ring pancreas.

During the time that the fistula was draining the patient's symptoms are also of interest. Immediately after the second opera-

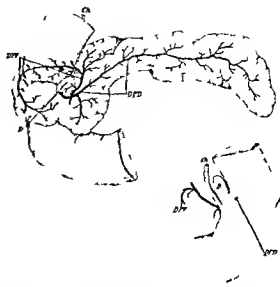


Fig. 6. Annular pancreas, ventral view. DPD, dorsal pancreatic duct; DPI, ventral pancreatic duct; Ch, choledochus. (After Cordes.)

tion she felt much better, her appetite, which had been entirely lacking, returned and she took fluids readily. During the 8 days that the fistula was draining profusely, she began to lose flesh visibly, she was constantly thirsty, complained of feeling weak and tired and upon the tenth day she began to vomit, although her appetite was good. Improvement began at the time of the administration of large amounts of fluid containing salt, soda bicarbonate, and glucose, with the coincident diminished secretion from the fistula. Elman found that the total drainage of pancreatic secretion in dogs was accompanied by regurgitation of intestinal contents into the stomach, vomiting, rapid emaciation, and death. It is suggested that relief of dehydration with maintenance of the chlorides and alkali reserve of the body might prolong the survival period of such animals.

The relative infrequency of annular pancreas (Baldwin found 1 specimen in 99 adult human bodies examined with reference to the structure of the pancreas) prohibits any discussion of operative procedures, except to suggest that duodenojejunostomy, as advised by Huggins for chronic duodenal ileus, is the operation of choice, since it affords a more

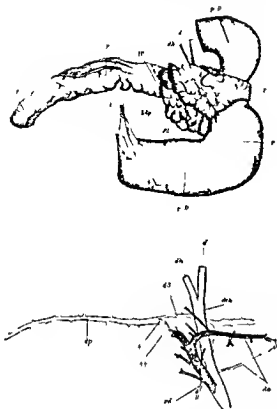


Fig 5 The annular pancreas is seen from the dorsal aspect producing a marked constriction in the duodenum. The lower figure gives the arrangement of the ducts of this specimen. (After Lecco)

there remained a deep encysted cavity, between the liver and gastrohepatic omentum above and to the left, the lateral abdominal wall to the right and the transverse colon and omentum below. The head of the pancreas was seen as a greyish reddened mass indurated and with distinct lobulations on its surface. The duodenum was not constricted and there was no obstruction to the lumen of the bowel. The body and tail of the pancreas were palpated and found normal in consistency and extent. No fat necrosis was found. Drainage was established through a stab wound in the right lateral abdominal wall.

The fluid removed from the abdomen digested starches, fat and casein, was strongly alkaline with a hydrogen ion concentration of 8.6 and was negative for bacterial growth on culture. It was unquestionably pancreatic secretion.

The day following operation the patient was brighter, felt better and was relieved of abdominal pain. There was continuous drainage of a clear, odorless, strongly alkaline fluid from the stab wound in the right side. The discharge was sufficient in

spite of frequent dressings, to wet the bed clothes and mattress. The skin surrounding the wound was covered with zinc oxide containing hydrochloric acid (10 per cent) and with kaolin but it was soon discovered that the acid dressing excoriated the skin, and thereafter zinc oxide and kaolin powder provided adequate protection. The amount of pancreatic secretion draining from the wound was estimated to be between 1,200 and 1,500 cubic centimeters for 24 hours.

On the eighth day when the discharge of pancreatic secretion was still profuse, her pulse rate had increased to 130 although her temperature remained normal. On the tenth day she thrice vomited large amounts of undigested food. The vomiting was repeated on the following day in spite of repeated gastric lavage. The patient felt hungry and had normal bowel movements; there was no distention nor tenderness in the abdomen and no masses were felt on palpation. The white cells numbered 17,450 with 86 per cent polymorphonuclears. Laboratory examination showed a blood urea of 59 milligrams per 100 cubic centimeters, a blood chloride of 396 milligrams per 100 cubic centimeters, and a carbon dioxide combining power of 40 cubic centimeters per 100 cubic centimeters of plasma. The patient was given per rectum 300 cubic centimeters of 5 per cent solution of bicarbonate every 4 hours, normal salt solution by hypodermoclysis and 10 per cent glucose in normal salt solution intravenously to compensate for the loss of chlorides and alkali through the draining fistula.

The intermittent vomiting ceased, the fistula stopped draining on the twentieth postoperative day, and the patient began to gain rapidly in weight and appearance.

The patient has been seen several times since her discharge from the hospital, and 6 months after the first operation stated that she is markedly improved. She has no abdominal discomforts, has gained in weight and eats well and although the headaches persist they are much improved.

The case of annular pancreas here presented affords an opportunity for a number of interesting observations. The symptoms manifested first were those attributed by Higgins to chronic duodenal ileus, namely intense headaches and an irritable stomach followed later in the course by vomiting. As Higgins states, "The vomiting of large amounts of bile stained fluid with evidences of retention, especially if associated with severe headaches, should arouse a suspicion of chronic duodenal ileus."

As shown by previous observers, a good sized duct always courses anterior to the duodenum in the ring of pancreatic tissue. In this case the duct was cut across, securely

## THE MECHANISM CONTROLLING MIGRATION OF THE OMENTUM

C BRYANT SCHUTZ M D KANSAS CITY MISSOURI

THE most important function of the omentum is to localize foci of peritoneal irritation. In performing this function the efficiency of the omentum depends, to a large extent, upon its ability to migrate to, and surround such, foci.

Of the many attempts that have been made to explain the mechanism controlling this migration, few have anything but fancy upon which to base their assumptions. Adams's theory that migration is caused by gravity, though often quoted, has long since been discarded. Fisher believes that migration is brought about by intestinal peristalsis. It has been pointed out, however, that the greatest movement of the omentum occurs after it has become infiltrated, and it is then so rigid that intestinal movements slide beneath it without producing any change in its position.

Hertzer believes that the chemotactic attraction between the area of irritation and the leucocytes contained in the infiltrated omentum incidentally pulls the omentum to the irritant focus. Among other things, he made the interesting observation that small pieces of corn pith placed free in the abdominal cavity become covered with leucocytes and in a number of instances, are later found adherent to the abdominal wound—a phenomena difficult to explain unless one assumes that the leucocytes attracted to the area of irritation (the abdominal wound) incidentally pulled the corn pith along with them. The theory implies, however, an initial directional movement of the omentum, and such is not the case. Furthermore, in the experiments to be reported the omentum migrated in the absence of leucocytic infiltration. However, the theory probably does explain certain phases of the omentum's migration.

## ANATOMY

Briefly, the omentum is a network of blood vessels, along the main branches of which varying amounts of fat are deposited. Sup-

porting the blood vessels is a thin, transparent, and somewhat elastic membrane formed by the union of two peritoneal plates and containing a delicate meshwork of connective tissue bearing minute blood vessels. These latter vessels are, in the resting omentum, practically empty. Only in the reacting omentum do they actually take on the function of blood vessels. They have been aptly called "potential" vessels.

The arterial blood supply arises from 6 to 8 fair sized branches of the gastro epiploic artery. Near their origin they give off very few branches and run a parallel and more or less straight course. As they approach the periphery of the omentum, their course becomes more tortuous and they give off many small anastomosing branches which divide into the small "potential" vessels afore mentioned.

Both the arteries and veins are but loosely attached to the omentum. The veins follow the course of the arteries and empty into the gastro epiploic vein.

In its so called normal position, the omentum extends from the transverse colon to the symphysis pubis below and to or over the colon on either side. Seldom, however, even in abdomens showing no evidence of disease, is it found occupying this position. Its peripheral portions are usually crumpled so that they do not reach much beyond the level of the umbilicus below and scarcely to the inner edge of the colon on either side. It thus occupies a smaller space than its size justifies. The tortuosity of the omental arteries is due to this latter fact rather than to any definite anatomical structure.

Above, the omentum is attached to the greater curvature of the stomach and to the transverse colon, to the left, to the phrenic and gastrosplenic ligaments, and on the right is continuous with the hepatic duodenal ligament. Not infrequently it is attached to the gall bladder, an attachment often erroneously considered pathologic.

complete relief of duodenal stasis than does gastro enterostomy. Furthermore, manipulation and trauma to the pancreas, which resulted in such distressing complications in this case, are thereby avoided. It may be suggested in passing that carcinoma of the head of the pancreas, if subjected to palliative operation, be treated by gastro enterostomy and cholecystogastrostomy, since the late stages of this hopeless condition are accompanied often by protracted nausea and vomiting. In one of our earlier cases there was complete gastric stasis with the accompanying vomiting and jaundice from pressure of a tumor of the head of the pancreas.

#### SUMMARY AND CONCLUSION

1 Twenty cases of annular pancreas have been reported in the literature. Four cases presented symptoms of high intestinal obstruction. Three were subjected to operation for relief of obstruction.

2 An instance of annular pancreas manifesting the symptoms of chronic duodenal ileus is reported.

3 The operation of releasing the pancreatic ring was followed by pseudocyst formation and drainage of the cyst resulted in a pancreatic fistula which healed spontaneously.

4 The metabolic disorders and symptoms accompanying the pancreatic fistula were relieved by the administration of soda bicarbonate by mouth and in rectal instillations, and by salt solution beneath the skin and intravenously.

5 This single experience with a very rare lesion indicates that rather than attempt a division of the abnormal ring of pancreatic tissue, it would be better to perform a duode-

nojejunostomy, avoiding thereby a possible pancreatic cyst or pancreatic fistula.

#### BIBLIOGRAPHY

1. ALBERG. Etudes sur les maladies du pancreas. Paris 1866. Quoted by Ancelet as cited by Baldwin.
2. BALDWIN W. M. Adult human pancreas showing an embryological condition. *Anat. Rec.* 1910 iv 21 and 197. A specimen of annular pancreas. *Anat. Rec.* 1910 iv 299.
3. BECOURT. Recherches sur le Pancreas. Strasbourg 1830. Quoted by Lecco.
4. BENEDETTI UMBERTO. Contributo allo Studio del Pancreas annulare. *Polichin* 1920 xxvii 81.
5. CORDS ELIZABETH. Ein Fall von ruengformigen Pancreas. *Anat. Anz.* 1911 xxxix 33.
6. ECKER A. *Ztschr. f. ration. Med.* 1867 xiv 334.
7. ELMAN ROBERT. Pancreatic juice and gastric acidity. *Arch. Surg.* 1913 xvi 1256.
8. GENERSICH ANTON. *Verhandl. d. V. Internat. med. Cong. Berlin* 1891 ii 140.
9. HIGGINS C. C. Chronic duodenal ileus. *Arch. Surg.* 1926 xiii 1.
10. LECCO T. M. Zur Morphologie des Pancreas annulare. *Sitzungsber. d. Wien Akad. d. Wissensch.* 1910 cxxx 391.
11. LERAT P. Contribution chirurgicale a l'etude du pancreas annulaire. *Bull. Acad. roy. de med. Bel.* 1910 April 30. Quoted by Benedetti.
12. MOYSE. Etude historique et critique sur le pancreas. 1832. Quoted by Lecco.
13. SANTOS REYNOLDO DOS. Deux lesions rares du duodenum. *Proc. V Internat. Med. Cong. Lisbon* 1906 sect. ix, 419.
14. STAMPA HUGO. *J. Am. M. Ass.* 1900 xxxv 43.
15. SYMINGTON J. *J. Anat. & Physiol.* 1885 xix 291.
16. TRATCHER J. S. *Med. Rec.* 1893. Quoted by Cords.
17. TREFKEN THEO. *Am. Med.* 1901 ii 816.
18. TIEDEMAN. Quoted by Schürmer. *A. M. Beitr. zur Geschichte und Anatomie des Pancreas*. Inaugural dissertation. Basel 1893. Quoted by Lecco.
19. VIDAL E. Quelques cas de chirurgie pancreatique. *Proc. VIII Cong. Surg. Paris* 1905 739.
20. WELKE D. P. D. Chronic duodenal ileus. *Brit. M. J.* 1911 ii 793.

NOTE.—Smetaria Hans. *Beitr. z. path. Anat.* 1913 lxxix 231 reports 3 cases of annular pancreas from the Pathological Anatomical Institute of the University of Vienna. In addition he cites 8 cases from the literature not reported in this article.

suddenly advance for, as near as could be calculated one eighth to one quarter of an inch and then suddenly stop. In its advanced position it seemed to pull on adjacent portions so that in a short time they too moved forward. I got the impression that the omentum was lightly stuck to the surface of the intestines (perhaps by surface tension between the fluid on the surface of the omentum and that on the surface of the intestines) and that advancement was momentarily resisted by this factor. At the end of the experiment, when migration was no longer noted the omentum was thickened with edematous fluid and everywhere rested on the surface of the intestines. Its lateral edges covered the colon on either side and its lower edge had migrated into the pelvis.

**Experiment 7** The omentum was removed from a woman who had just died from an extra abdominal disease. The left portion and all gastric branches of the gastro epiploic artery were carefully tied off. The omentum was floated on water and its edges crumpled as much as possible. Tap water was injected into the right gastro epiploic artery.

Following the injection the omentum spread out in all directions. The crumpled edges straightened and both lateral and lower edges advanced. As long as the pressure was maintained in the artery, the edges of the omentum retained their advanced positions but as soon as the pressure was released they receded with an abruptness suggestive of an elastic recoil.

This experiment was repeated once with a similar result.

**Experiment 9** Through an upper abdominal incision the right gastro epiploic artery and all its omental branches were tied off so as to deprive the omentum of blood supply. Through a separate incision a pledget of gauze lightly soaked in turpentine was sewed into the peritoneum in the right lower quadrant. Twelve hours later the abdomen was opened.

In the region of the gauze pledget very marked inflammatory reaction was present. Peritoneal fluid was increased and peristalsis was hyperactive. The omentum however despite the hyperperistalsis had not changed its position.

In these experiments the omentum migrated when pressure in the omental arteries was increased. When the pressure was increased the arteries lost their tortuosity. As they straightened they advanced in the direction of their initial blood flow. The omentum migrated at the same time, in the same direction and to the same extent as the arteries. Its migration was independent of both leucocytic infiltration and intestinal peristalsis.

The straightening and advancement of the omental arteries which occurs when they

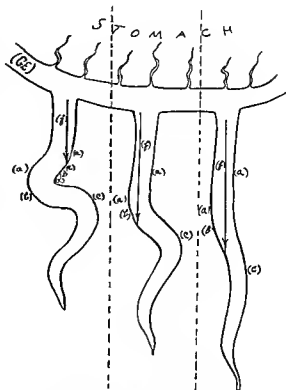


Fig 1 Diagrams showing mechanism controlling migration of the omentum

become hyperæmic is purely a mechanical phenomenon. As shown by Newton's second law of motion, change of motion (momentum) is proportionate to the force applied and takes place in the direction of a straight line, in which an applied force acts. It is the disposition of the moving force to continue to act in the direction in which it was initiated.

When the omental arteries, in the presence of peritoneal irritation, become hyperæmic the momentum, and, therefore, the force, of the blood increases. Since the omental arteries (Figure 1, first diagram) branch from the gastro epiploic artery, *ge*, at right angles and continue in a straight line for a considerable distance, the direction of this increased blood force is initially in the general direction of the pelvis. It is the tendency of this force to continue in this direction, regardless of any obstruction which it may meet.

When, therefore, the force of the blood strikes the first tortuosity, *a*, *a'*, in an omental

## REACTION TO IRRITATION

In the presence of peritoneal irritation, the first change in the omentum is generalized active hyperæmia. This is followed by a serous and cellular exudate in its substance and on its surface. The vessels lose their tortuosity and the omentum gradually spreads out in all directions eventually extending over practically the entire lower abdominal cavity. When one portion of the omentum comes in contact with the focus of irritation, it adheres to it. After a variable time adjacent portions become adherent to and eventually surround the entire area. When localization has been completed much of the generalized reaction of the omentum subsides and only those portions in direct contact with the focus retain their high state of reaction. The exudate on the surface of the omentum fills up and effectually seals any spaces which have been left open. The end result is a thick, watertight wall which separates the irritant from the rest of the peritoneal cavity.

## PURPOSE

In studying the reaction of the omentum to peritoneal irritation, I noted that as the arteries became hyperæmic much of their tortuosity was lost and that coincident with this the omentum began its migration. I was reminded of seeing a loosely curled garden hose tend to straighten and its distal end advance when an increased amount of water was caused to flow through it. It occurred to me that a similar mechanism might explain migration of the omentum. That is, as the arteries become hyperæmic the increased blood pressure causes them to straighten out. As they straighten all portions of the arteries necessarily advance in the general direction of the blood flow. The omentum, being loosely attached to the arteries is incidentally pulled by them to their advanced position.

## EXPERIMENTS

To test the principle of this idea I sewed a two foot section of an eighth inch rubber tube to an ordinary towel. The towel was floated on water and crumpled up until the attached tube assumed a tortuous course. Water was then injected through the tube

Immediately following the injection the tube straightened and as it did so advanced in the direction of the initial water flow. As it advanced it carried the attached towel with it. The effect was increased, and much less pressure was needed, if the injection was done in a manner to simulate arterial pulsation.

*Experiment 1.* Under ether anesthesia a dog's omentum was exposed through a long midline incision. All the gastric branches and the left end of the gastro-epiploic artery were tied off. A solution of acacia (of approximately the same specific gravity as the dog's blood) was injected into the right gastro-epiploic artery.

When first exposed the omentum followed in an irregular fashion the undulations of the intestinal loops in some places resting on the surface of the intestines in others especially near its free margin, dipping into the spaces separating them. The free edges of the omentum were, as usual irregularly crumpled.

Following the injection the smaller as well as the larger arteries became definitely distended. Depressed portions of the omentum rose to the surface of the intestines and the whole organ seemed to flatten out. The free edges migrated in the general direction of their respective blood flow—the lateral edges advancing laterally, the lower edges moving toward the pelvis.

Using the tip of the uphold as a fixed measuring point the maximum longitudinal migration was slightly less than 3 inches. Estimated lateral migration was between one half to three quarters of an inch.

This experiment was repeated four times in different dogs. In each instance similar results were obtained.

*Experiment 6.* The omentum of a dog was exposed as before. The arteries to the omentum were tied off as in the previous experiments. In addition to this three of the omental veins were tied off near their entrance into the gastro-epiploic vein. The dog was kept under ether anesthesia.

When first exposed the omentum occupied approximately the same position and had the same general appearance as the omentum described. In half an hour hyperæmia of the omentum had become definite. As the hyperæmia increased the arteries and especially the small anastomosing branches began to lose their tortuosity. With abrupt movements the more central portions of the omentum began to spread or flatten out as in the previous experiments. Gradually this extended outward toward the periphery. The free edges the lateral as well as the lower then began an irregular advancement. This migration did not occur at the same time in all portions. Instead one area would

suddenly advance for, as near as could be calculated one-eighth to one quarter of an inch and then suddenly stop. In its advanced position it seemed to pull on adjacent portions so that in a short time they too moved forward. I got the impression that the omentum was lightly stuck to the surface of the intestines (perhaps by surface tension between the fluid on the surface of the omentum and that on the surface of the intestines) and that advancement was momentarily resisted by this factor. At the end of the experiment, when migration was no longer noted the omentum was thickened with edematous fluid and everywhere rested on the surface of the intestines. Its lateral edges covered the colon on either side and its lower edge had migrated into the pelvis.

*Experiment 7* The omentum was removed from a woman who had just died from an extra abdominal disease. The left portion and all gastric branches of the gastro epiploic artery were carefully tied off. The omentum was floated on water and its edges crumpled as much as possible. Tap water was injected into the right gastro epiploic artery.

Following the injection the omentum spread out in all directions. The crumpled edges straightened and both lateral and lower edges advanced. As long as the pressure was maintained in the artery the edges of the omentum retained their advanced positions but as soon as the pressure was released they receded with an abruptness suggestive of an elastic recoil.

This experiment was repeated once with a similar result.

*Experiment 8* Through an upper abdominal incision the right gastro epiploic artery and all its omental branches were tied off so as to deprive the omentum of blood supply. Through a separate incision a pledget of gauze lightly soaked in turpentine was sewed into the peritoneum in the right lower quadrant. Twelve hours later the abdomen was opened.

In the region of the gauze pledget very marked inflammatory reaction was present. Peritoneal fluid was increased and peristalsis was hyperactive. The omentum however despite the hyperperistalsis had not changed its position.

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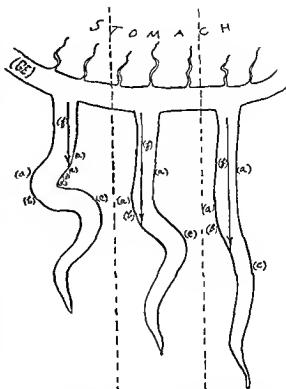


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artery, it acts in the direction of the arrow, *f*. It has its greatest effect on the area *i*, which lies directly in its path. In the quiet omentum, since only a minimum amount of blood is flowing through the artery the force is not sufficient to affect the position of this portion of the artery. In the reacting omentum when hyperæmia causes an increase in the blood force area *i* is pushed forward. When advancement of *i* becomes limited by its attachment to the proximal portion of the artery it moves laterally—being as it were pushed aside by the force of the blood. These movements necessarily cause straightening and advancement of the tortuosity *a a*. Areas *j k* are successively subject to the same changes with the result that *a a'* advances to assume the position shown in Figure 1 second diagram. Continuation of this process causes similar changes to occur at *b* and *c* so that eventually the artery assumes the position shown in third diagram.

This same mechanism controls changes in position of the branches of the main arterial trunks. For this reason arteries in all portions of the omentum share in the advancement of the larger longitudinal arteries.

The omentum, which is loosely attached to the arteries is pulled by them to their advanced position. Thus migration of the omentum is secondary to migration of its arteries.

#### THE MECHANISM OF THE MIGRATION OF THE OMENTUM

Migration of the omentum to the focus of peritoneal irritation is a blind mass movement of the entire organ. It occurs laterally as well as longitudinally regardless of the position of the irritant.

This blind generalized migration continues until one portion of the omentum comes in contact with the area of irritation. When this occurs generalized reaction and therefore, generalized migration ceases. Only those portions in direct contact with the area of irritation retain their state of reaction the rest of the omentum gradually subsiding to a more or less normal state.

All activity now becomes centered about the area of irritation. Adjacent portions of the omentum begin to surround the focus of irritation by movements that differ from generalized migration in that they are definitely directional in character. This directional migration continues until all or practically all, of the area of irritation is surrounded.

A great deal of this local migration is caused by the same mechanism that controls generalized migration—the arteries in the locality retaining their hyperæmia and continuing their migration. There is reason to believe however that part of it may be explained by Hertzler's theory that the leucocytes embedded in the omentum pull it to the area of irritation as they move toward the latter in response to chemotaxis.

#### CONCLUSION

From the experiments reported the following conclusions seem justified.

1. Migration of the omentum is controlled and caused by migration of the omental arteries.

2. Migration of the omental arteries occurs in the direction of their respective blood flow and is caused by increase in the local blood force following hyperæmia of the omental arteries.

Examination of the anatomy of the omentum and observation of its changes during migration substantiates these conclusions. The question as to why the omentum the only function of which seems to be a mechanical one i.e. walling off and localization of foci of peritoneal irritation should have such an exuberant blood supply may be answered by this theory. In this connection it is interesting to note the resemblance that the structure of the omentum bears to erectile tissue and to recall the fact that movements of erectile tissue are controlled by a mechanism similar to that described.

#### REFERENCES

1. ADAMS: The great omentum Philadelphia M J 1895
2. FISHER: Some function of the omentum Brit M J 1906 1 233
3. HERTZLER: The Peritoneum vol 1 309 St Louis C V Mosby Co 1919

THE INJECTION TREATMENT OF VARICOSE VEINS<sup>1</sup>

GEZA DE TAKATS M.D. M.S. F.A.C.S., AND HAROLD QUINT B.S. M.D. Chicago

WHILE it is true that Pravaz in ventor of the hypodermic syringe, as early as 1853 injected into varicose veins perchloride of iron and that others (1 and 18) have used for this purpose many coagulating substances such as alcohol, tincture of iodine, Lugol's solution, and carbolic acid, it is only in the past 10 years mainly through the efforts of Linser, Sicard and Nohl that hypertonic solutions of sodium chloride, sodium salicylate and sugar have replaced the coagulating substances and have become widely used in the treatment of varicose veins. The daily growing literature on this subject has been covered in the articles of McPheeters and in a previous paper by one of us (6). A wave of enthusiasm followed the introduction of this simple method and as is so often true we find that its use resulted at times in untoward reactions, necrosis, and even fatalities as summarized by McPheeters and Rise (15).

Since November 1, 1926, a clinic for the treatment of varicose veins has been conducted at Northwestern University. It has been our aim to select the safest and yet sufficiently effective solutions for injection to evaluate tests for arterial and venous circulation and finally to determine late results with the help of a follow up system. At the same time studies have been carried on to determine venous pressure and the dioxide and carbon dioxide content of the blood in varicose veins. These studies have been reported elsewhere (7).

In this paper we wish to present the method of management which has been gradually evolved during the course of 3 years—a method based on our experience in a series of 500 cases in which over three thousand injections were made.<sup>2</sup>

## EXAMINATION OF THE PATIENT

In the history of the patient, a hereditary factor was elicited in 65 per cent. The lack

<sup>1</sup> The complete history made in 1,000 patients have been treated. Half of them had no clasp of the vein and the other half had it.

or diminution of elastic tissue as a dominant symptom of asthenic constitution has been frequently described since the pioneer contribution of Stiller. Flat feet and bunions have been noted in 58 per cent of all cases. Curtius has shown remarkable family trees indicating a dominant type of heredity in patients afflicted with a "varicose status." Such patients may present varicosities of the septum and consequent bleeding from the nose, small cutaneous nevi, and spiderlike telangiectases. Often a hypoplasia of the entire vascular system including the heart may be present. We were frequently impressed with the vascular fragility of young patients afflicted with varicose veins. Such patients would develop blue bumps at the slightest injury, yet routine determination of bleeding time, coagulation time, and platelet counts would fail to detect any changes, so that a vascular fragility with lack of elasticity as a constitutional factor, had to be accepted as a cause for the frequent rupture of small vessels. A developmental anomaly in the variation of the course and length of the short saphenous vein has also been given consideration (Figs. 1, 2, 3). Kosinski has pointed out that the short course of the small saphenous vein in man is probably an adaptation to posture and that the persistence of a long course of this vein, either emptying into the femoral vein or into the great saphenous on the thigh, may well explain some of the varicosities in the popliteal fossa and some abnormal configurations described by dilated veins. Sometimes conditions resembling a true phlebectasia with multiple cavernous sinuses and hypertrophied walls are produced (Figs. 4 and 5).

The first appearance of varicose veins was found to be at puberty in 26 per cent of our cases. The effect of menstruation on varicosities was elicited in almost every case. The effect of pregnancy on further increase in venous pressure is well known. Each subsequent pregnancy aggravates the existing dilatations

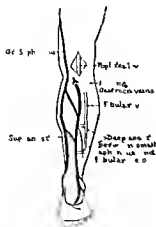


Fig. 1. Diagram of a short course of the short saphenous vein (After Kosinski)

A history of thrombophlebitis following pregnancy, pelvic operations or infectious diseases particularly typhoid fever and influenza has been elicited in 10 per cent of all cases coming to our clinic. Such a history immediately suggests the question of sufficient deep venous return. Trauma followed by dilated veins distal to the injury was found in 21 cases. Mechanical factors, such as prolonged standing as night watchman, as waiter and as laundress were found in 63 per cent. The effect of constricting garments was studied in a previous communication (7). A possible elimination of such factors seems desirable.

In the *physical examination* of the patient, the respiratory and vascular systems deserve most attention and in the general examination should be included a complete blood count, urinalysis, and Wassermann test. Diseases such as gastric ulcer, diabetes and hypertension to mention only the most frequent can be treated simultaneously with the veins while other conditions require immediate surgical attention and in their presence injection treatment should be postponed or not be undertaken. Hyperthyroidism should be treated before any other condition is dealt with. Basal metabolism rates should be determined if hyperthyroidism is suspected clinically. In our series 4 cases of hyperthyroidism were found and relieved before the treatment of the veins was started. In the presence of malignant growths or active

tuberculosis the injection treatment of varicose veins is not warranted. Acute infectious diseases, even acute colds, should be treated first. It is impossible to enumerate all possible coexisting diseases, but it should be stated that the treatment of the veins should never precede that of the more urgent conditions. This must be emphasized since the injection treatment of varicose veins has become a part of office practice and since as the technique is so simple many a practitioner has been misled to hasty and unwarranted injections.

#### *Tests of arterial and venous circulation*

In a previous communication (7), it has been pointed out that in beginning arterial occlusion of the lower extremities, as seen in senile and diabetic gangrene and in thromboangiitis obliterans the veins are frequently dilated and even inflamed. This is particularly true of Buerger's disease. In this series 6 cases were found in which injections had been made into the veins of such patients elsewhere. In these cases because of the nature of the disease the arterial occlusion will progress and possibly gangrene will develop, yet the patient will attribute the turn for the worse to the injections. Therefore, we have tried to eliminate such patients from the injection treatment although occasionally a well selected case may be benefited by an obstruction to the venous return (8). At all events patients must be told that their complaints—the intermittent claudication, the cramps in the sole of the foot so often attributed to flat feet—are due to poor arterial circulation.

The *arterial circulation* is estimated first by palpating the pulse of the dorsalis pedis of the tibiais postica and of the popliteal arteries. This estimation is especially important if other evidence of peripheral arteriosclerosis or if diabetes is present. The pulsation of the arteries of the foot may not be palpable because of ankle oedema, induration, scars or ulcers. An X-ray picture of the leg may be taken to show calcification of the arteries. If the roentgenograms are taken with care and the proper technique the dilated veins will also show (Fig. 6). The constriction test of Moszkowicz which consists of the observation of the reactive hyperæmia following

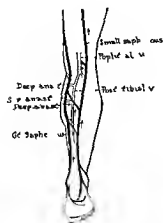


Fig 2 Diagram of a long course of the short saphenous vein (Alter Kosinski)

complete arterial obstruction is painful, not entirely harmless and not easily estimated. The angle of circulatory insufficiency as described by Buerger, can be tested only when there is rubor in the dependent position. In the response of the cutaneous vessels to histamine, we have found a simple clinical method for testing arterial circulation. Following Starr's brief communication on the subject, we have used this test routinely in all patients above 50 years of age and also in all patients in whom poor arterial circulation was suspected.

Histamine acid phosphate in a 1:1000 solution is used. The solvent is normal saline solution. The solution can be kept in the ice box for about 2 weeks without losing its potency or it can be kept in sterile ampoules in which it will probably remain stable for a long time. A drop of the sterile solution is placed on the skin, which has been previously gently swabbed with alcohol. The skin should not be rubbed too vigorously, otherwise the reactive hyperemia may simulate or cover the histamine reaction. With a fine hypodermic needle from 6 to 7 punctures are made through the drop of histamine. The needle should penetrate the cornified layers of the skin but should not cause any bleeding. Normally, as described by Lewis, a triple response ensues: a purple spot at the site of the puncture, a wheal superimposed on the purple spot, and a red flare around the wheal. The red flare is due to an active vasodilation of the

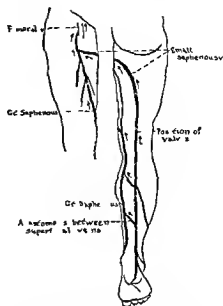


Fig 3 The short saphenous vein empties into the long saphenous vein high up on the thigh

minute vessels followed by an influx of arterial blood. It appears normally in  $2\frac{1}{2}$  to 5 minutes and increases in intensity up to the fifteenth minute. We have discussed elsewhere (7) that the delayed appearance or absence of the flare means a lack of arterial inflow. A spasm or occlusion of the small vessels, which the histamine is unable to overcome, may equally be factors.

If such flares are elicited above the knee, below the knee, at the middle of the calf, and at the ankle, the level of impaired arterial inflow can be rapidly determined. The tested leg should be kept horizontal, otherwise the influx of arterial blood may be influenced by posture. A small delay at the ankle, particularly in older people, may not be called pathologic. The absence of a reaction is always a serious sign and patients in this condition may be considered to be in a stage of impending or at least potential, gangrene (Figs 7 and 8).

The venous circulation is tested mainly in regard to an adequate venous return in the deep veins. The "milk leg" following pregnancy, pelvic operations or infectious diseases together with a diffuse hard edema which appears to be due to lymphatic

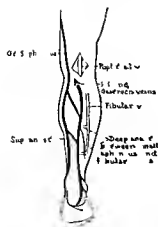


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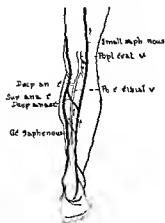


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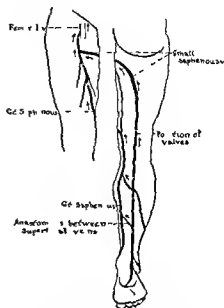


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Fig. 4

Fig. 4 Localized phlebectasia above popliteal fossa not suitable for injection treatment.



Fig. 5

Fig. 5 Low power photomicrograph of veins shown in Figure 4. Injection into such multiple sinuses seems futile.



Fig. 6

Such a cutaneous phlebectasia, a transition between varicose veins and an aneurysm is excised.

Fig. 6 Marked varicosities of the lower saphenous vein. Courtesy of Dr. W. Bronson.

obstruction makes the saphenous system invisible and in such instances injections are not only inadvisable but impossible. More difficult is the decision as to treatment when the swelling gradually diminishes after the use of elastic support or paste boots and the veins become visible and are dilated and tortuous. Often following a thrombosis of the iliac vein or the vena cava an extensive collateral circulation develops on the anterior abdominal wall. These of course should be left alone. However if in spite of the tortuous veins on the thigh and calf the ankle is not oedematous in the ambulant patient we can be quite sure that the deep venous circulation is adequate. The superficial venous system with insufficient valves is not functioning anyway; the flow of blood is reversed in it as shown by the Trendelenburg test (Fig. 9) and by measurements of venous pressure in various positions (7).

A simple test of patent deep circulation is that of Perthes which we have slightly modified. A blood pressure cuff is thrown around the thigh in the standing position and is inflated just enough to compress the saphenous vein. Next the patient is asked to walk to and fro or to flex and to extend his knee about ten times. During this procedure the calf muscles contract, squeeze the blood out of the deep veins, and aspirate the blood from the vari-

cocities. The dilated veins must diminish in size, if the deep venous circulation is patent. To demonstrate better the loss of blood following this sucking action the blood pressure cuff is now deflated and we find that the blood rushes in from the saphenous vein and fills up the varix to its previous size. If there is no appreciable diminution in the size of the dilated veins when the patient walks an increased venous pressure must be present in the deep veins, a fact which signifies that obstruction is present somewhere between the veins of the calf and the vena cava.

A similar test but one which requires a venous pressure apparatus is the measurement of venous pressure with patient in the horizontal position (7). The venous pressure which may be as high as 100-150 centimeters of water when the patient is in the standing position becomes normal when the patient assumes the horizontal position provided the deep circulation is unobstructed. In case of deep venous obstruction high readings are obtained with the patient in the horizontal position as the deep venous pressure is transmitted and prevents the emptying of the superficial veins. Such pressure determinations are not necessary in the general run of cases but do serve for a better understanding of faulty circulation. The lack of edema and in case of edema the test of Perthes is en-

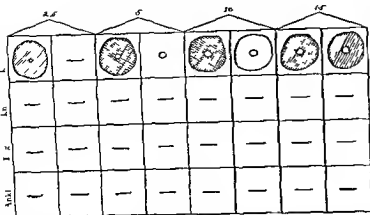


Fig 7

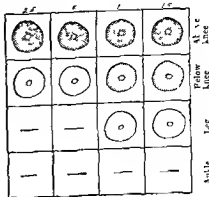
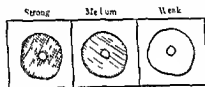


Fig 8

Figs 7 and 8 Charts showing reaction in two patients. The reaction is considered positive when a red flare appears around a wheel at the site of the test. The reaction normally appears in 5 minutes. Figure 7 is the chart of a night watchman aged 47 years in whom no palpable pulsation could be felt in the left dorsalis pedis and posterior tibial arteries. Two weeks after this test the left fourth toe became cyanotic later turning black. Patient was sent to the hospital. In Figure 8 we have chart of a diabetic who had many varicosities of the right leg. Pulse was fair in the dorsalis pedis and posterior tibial arteries.



tirely sufficient for the estimation of the deep circulation.

#### TECHNIQUE OF INJECTIONS

The patient's leg should be in the *hori-  
zo-  
ntal* position. This position as particularly emphasized by Sicard is the one in which the blood is the most stationary and in which the relaxation of the calf muscles permits the injected fluid to stay in place for a longer period. As shown in a previous communication (7) the venous pressure with the leg in the standing position is so high in the varicose vein that the injected fluid is rapidly washed away to the periphery. Furthermore this position of the leg is preferable for it permits as little blood as possible in the vein thereby preventing unnecessary dilution of the hypertonic solution and insuring better contact of the irritant fluid with the intima. Usually two injections are made at one sitting, one at the highest palpable vein and the other at the lowest palpable dilatation of the same segment. We have never injected higher than the middle of the thigh, but we usually do not inject above the knee. After the selected site of injection is gently rubbed with alcohol an intravenous needle with short bevel and preferably of rustless steel and on a 10 cubic

centimeter Luer Lok syringe, is inserted into the vein. The syringe is filled with 10 cubic centimeters of a 50 per cent glucose solution. As soon as blood can be aspirated into the syringe the second and third fingers of the left hand gently strip the vein proximally and distally from the inserted needle and maintain compression on the segment to be injected. Thus the vein is emptied as much as possible, before the injection is made. The injection is made slowly and is perfectly painless, as long as the needle is free in the lumen. When the needle is withdrawn a dental pad or a small felt pad is placed on the site of injection and is pressed against the vein with a wide adhesive tape. The pressure should be considerable and its proper maintenance for at least 48 hours is very important. This pressure serves to keep the inflamed walls of the vein in the closest possible contact and thus favors obliteration.

The solution used most frequently is 50 per cent glucose.<sup>1</sup> When the injection treatment was started in our clinic sodium chloride

<sup>1</sup> Since this article was submitted for publication we have adopted the usage of 50 per cent Amino Acid (A. A. C.) as a synonym for 50 per cent glucose. A mixture of 50 per cent dextrose and 50 per cent sodium chloride is also used. The two solutions are kept in separate ampoules and are mixed in the syringe in equal parts. It is less irritating. A total amount of 5 cubic centimeters is injected.



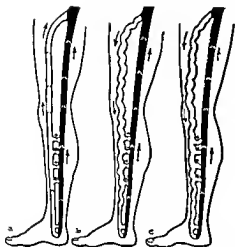


Fig. 9 The negative, positive, and doubly positive Trendelenburg test. The patient's leg is elevated and the dilatations are emptied. Next pressure is made on the course of the long saphenous vein and the patient is asked to stand up. If the veins remain empty or slowly fill up from below and do not change in size after the pressure is relieved the test is negative. There is no reversed flow in the saphenous system. a If the veins remain empty so long as the pressure is maintained but fill up from above with a sudden gush when the pressure is relieved the test is positive; the flow of blood in the saphenous vein is reversed. b If however the veins fill up suddenly on standing in spite of saphenous compression there is a reflux from the deep veins. Releasing the compression may produce a further filling of the veins thus making the test doubly positive. c This latter condition which indicates a valvular insufficiency of the anastomotic veins is not favorable to injection treatment and is a frequent cause of recurrence (Diagram from Homan)

sodium salicylate, quinine, and urethane were given a trial. Glucose proved to be the blandest, least irritant. There is no danger of necrosis if the solution is placed beside or leaks out of the vein. There is no or scarcely any cramping following the glucose injection. Glucose is non-toxic and systemic reactions as seen with salicylates and quinine are absent. The action of glucose is not so prompt as that of the three other solutions but the reaction following its use is practically confined to the intima. Periphrlebitis, an infiltration and subsequent pigmentation which has been described after the use of the other solutions, has not been observed. However it is true that large dilatations, particularly if there is an appreciable reflux from the deep veins, can not be obliterated with glucose. In such cases we have constantly felt the necessity of using more irritating solutions. Seventy-five per

cent invert sugar proved to act more promptly than 50 per cent dextrose. The disadvantage of invert sugar lies in its great viscosity necessitating the use of large needles. A solution of 15 per cent sodium salicylate in 50 per cent dextrose has shown very prompt obliterating effect. However, while we were able to get large firm thrombi in patients who did not respond to dextrose, there was marked pallor, vertigo and cramps in some cases. Furthermore, the alkaline sodium salicylate will caramelize sugar and the injection of such a solution is not advisable. A 10 per cent solution of quinine and urethane, not exceeding 1 cubic centimeter at one injection and 2 cubic centimeters at one sitting, gives satisfactory results in dextrose resistant cases. Here again, the injection should be given, if possible, with the patient in the horizontal or at least in the sitting position. Several patients have become dizzy when quinine was injected while they were in the standing position.

The use of dextrose in diabetics is not contra-indicated, but one unit of insulin should be administered with every 3 grams of sugar or corresponding restrictions must be made in the glucose intake of the patient.

The amount of dextrose injected at one point is usually 10 cubic centimeters never more but frequently less, if the vein is small and the walls are thin. Of the quinine 1 cubic centimeter is injected with a fine hypodermic needle and a 2 cubic centimeter tightly closing syringe.

#### OUTLINE OF MANAGEMENT

It is almost impossible to foretell the necessary number of injections. This will depend on the site and extent of varicosities on the intensity of the backpressure on the presence of reflux from the deep veins and finally on the condition of the wall of the vein to be injected. Thickened walls with a shrunken scarred intima will not respond as readily as a thin walled vein. On the other hand the presence of latent infection in the wall may result in a sudden obliteration of a long segment with marked periphrlebitis. There has been no complication even in such cases the temperature remains normal the tissue exudate is absorbed and there is no suppuration.



Fig 10 Drawing of a vein excised immediately after injection with 50 per cent dextrose. There is a small sub-intimal hemorrhage at the insertion of the needle. The intima was swollen hyperemic but no thrombus has as yet formed.

The patient is asked to wear an elastic bandage or stocking during the treatment. This helps to keep the veins collapsed and diminishes venous pressure. The patient goes about his or her daily work without any restrictions. Heavy manual labor is not excluded. However unusual exertion in patients not used to it is not permitted.

It is advisable to start injections simultaneously at the highest and lowest palpable point of the same segment the highest point never exceeding the middle of the thigh. It is occasionally possible to obliterate with two such injections one entire segment. If this is not accomplished the following injections will be made between the two previous injections. If one segment is completely obliterated another one is selected for injection. If both legs are affected, one may treat them simultaneously although much will depend on the individual reaction of the patient.

If the veins are enlarged above the middle of the thigh, we ligate the long saphenous vein with a small transverse incision in the ambulatory patient and then follow with injections. Such ligations have also been made lower about a handwidth above the knee if the pressure seemed too great. Such ligations aid materially in obliterating the veins below, as they reduce the pressure when patient stands at least temporarily (7).

When all the visible and palpable dilations have been obliterated, we ask the patients to wear an elastic support for 3 weeks longer. At the end of that time they are permitted to go around without any bandage

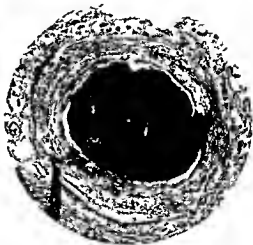


Fig 11 Section of a vein one week after the injection of 50 per cent dextrose. The intima is destroyed and an obliterating thrombus has formed. There is a marked dilatation of the vasa vasorum.

but we ask them to return in 1 month. Not infrequently one or two more injections may be necessary to cure varicosities in veins that have not been completely obliterated in the first treatment. An exact follow up system is essential in evaluating the end result in each individual case.

#### **PATHOLOGICAL STUDIES OF INJECTED VEINS**

In a previous paper by one of us (5), the fact was stressed that the coagulation of the blood in the injected segment is only secondary to the endophlebitis due to physico-chemical irritation of the intima. If a vein is injected with 50 per cent dextrose solution and immediately excised, there is no thrombus formation visible (Fig 10). In performing our preliminary vein ligations we have frequently injected the vein before ligating it and were thus able to study the macroscopic appearance of the intima. The intima smooth, pale and glistening as it normally is, turns red and velvety, with occasional sub-intimal hemorrhages. Thus endophlebitis which corresponds to a catarrhal inflammation of any endothelial surface produces an exudate. The rationale of our method of localized compression consists first in producing stasis in the vein an important factor in thrombosis second in reducing the backpressure of the



Fig 12 Same section high power. Note the active organization of the clot as compared with Figure 13

column of blood and third in approximating the injured intimal surfaces. The organization of the thrombus which occurs slowly and gradually in the spontaneous clot will proceed so to speak simultaneously with the formation of the clot as the outpouring of fibrinous exudate will anchor the agglutinated corpuscular elements (Figs 11, 12, 13).

It is evident however that not all thrombi caused by injection treatment will show the same picture. A secondary clot, a true red thrombus, may form on top of the firmly adherent thrombus. This is all the more liable to happen when as a result of previous attacks of phlebitis known or unknown to the patient the intima is vulnerable, thickened (Fig 14). The importance of ligating the long saphenous vein if it is wide open and feels hard, lies not only in reducing the backpressure but in preventing such an ascending superimposed clot from reaching the saphenofemoral junction.

The result of well organized total thrombi is complete obliteration of the vein which turns into a fibrous cord. Such cords are well palpable even after months but gradually diminish in size and are not visible. However if the injection is followed by a marked periphlebitis, a brownish pigmentation may occur

along the course of the vein. We have not seen any such pigmentation after the use of glucose solution but have observed it after the use of salicylates, quinine, and urethane.

The organization of the clot may however follow a less fibrous and more vascular character. Small sinuses originating in newly formed capillaries form in the thrombus and contain circulating normal red cells. The walls of such intrathrombal canals are lined with endothelium so that they must originate from the capillary buds of the granulation tissue (Fig 15). Even more interesting is the dilatation of sinuses around the internal limiting membrane. These sinuses which may be seen to encircle the entire wall of the vein at the internal limiting membrane are also lined with endothelium and form a new circulation in the wall of the thrombosed vein (Fig 16). They must have afferent and efferent vessels otherwise normal red cells could not be seen in them. Cornil and Ranvier (17) have described a cavernous transformation of thrombosed veins. In our material one patient who had been injected elsewhere with hypertonic sodium chloride solution showed such cavernous transformation. Because of the multiple cavernous character of such a vein, it is difficult to get the needle into the lumen and the injection will be frustrated by a growing hematoma before the solution can be safely injected.

A real restoration of the obliterated lumen may also take place, either by a purulent softening of the thrombus with subsequent signs of pyæmia or embolism or by a gradual recanalization as a result of persistent increase in pressure. If the pressure from the saphenous distribution or from the deep veins is constantly high because of valvular insufficiency the recanalization will manifest itself in a true recurrence.

#### UNTOWARD SYMPTOMS FOLLOWING INJECTION

Untoward symptoms following injection can be grouped under immediate and late.

The immediate symptoms following the injection of 50 per cent dextrose are very slight but vary greatly. The reaction following the first injection is usually greater than after subsequent injections. This would indicate



Fig. 13. Static thrombus in the iliac vein. In spite of the age of the thrombus as shown by the intima scar there is no tendency to organize the clot.



Fig. 14. Chronic periphlebitis. The muscular layer has been replaced by fibrous tissue. The intima is thick and contains small areas of round cell infiltration. Injection of such a vein may result in acute phlebitis and periphlebitis.

that the patient's anxiety and the fear of the unknown lowers the threshold for pain stimuli. Also in women the complaints are more marked than in men. Most men receive the injection without any painful sensation. The cramping pain must be differentiated from the pain following a perivenous injection. If the needle is not in the vein, a blanching and ballooning out of the skin occurs. Simultaneously a sharp, localized burning pain is complained of which is a better danger signal than the visible infiltration of the subcutaneous tissue. The cramping pain which follows a correct intravenous injection occurs only after a minute or two, evidently at the time when the hypertonic solution reaches the nerve fibers in the adventitia either through the wall of the vein or through the capillaries. At the same time because of the stimulation of the sympathetic perivenous fibers an active contraction of the vein occurs, which may be so extensive and last so long that a second injection is not possible. This active venous contraction has been observed not only on the exposed vein but in a great many instances during the usual treatment. The veins empty, their walls become palpable and give the clinician a chance to estimate their thickness. Phleboliths become palpable.

This cramp, which is described by patients as exactly the same sensation as they have experienced on stretching their limbs in bed or as occurs when the limbs are put in cold water, lasts only a few minutes. It is the most frequent symptom noted. The cramping is very much milder after injections of dextrose than after those of sodium chloride or sodium salicylate. With quinine and urethane, a moderate cramping is observed.

Other symptoms such as pallor, dizziness, nausea that may accompany any intravenous injection, sometimes occur. Of our entire series, one woman always became faint as long as she remained in the sitting position during the treatment, another had to lie down if the injection was given while she kept the standing position. This *postural hypotonia*, which occurs in individuals with an unstable vasomotor mechanism is probably exaggerated when hypertonic solutions are injected.

The injection with patient in the horizontal position then is desirable also from this standpoint. However, when the veins become partially obliterated by previous injections the sitting or standing position must be resumed. In our fairly large series of cases, only 2 could not stand the elevated posture.



Fig. 15 Varicose vein injected 3 months previously with 50 per cent dextrose. There was a marked reflux from the deep veins. There is an irregular sinus around a valve and another one in the middle of an old hyaline thrombus. There are narrow sinuses at the periphery of the thrombus. These are not artefacts as circulating red cells can be seen in them with higher magnification.



Fig. 16 Old hyaline thrombus. Vein has been injected with 50 per cent dextrose 2 months previous to excision. There was a marked backpressure from the long saphenous vein which had not been ligated in this patient. There are several sinuses within the thrombus. A large partial thrombus is seen in one of the sinuses that formed around the internal limiting membrane. These cavernous sinuses are very hard to reinject. The needle may not find the lumen and the response to the irritant solution is very poor. Such recurrences are the result of continuous pressure on the thrombus from above or from the deep veins.

In 2 cases in our series 10 cubic centimeters of the 15 per cent concentration of sodium salicylate produced violent abdominal pain, faintness, and dizziness followed by a chill. No further symptoms developed. Since these two instances we do not inject more than 3 cubic centimeters at the first sitting, although more than 50 patients tolerated the 10 cubic centimeter dose without any reaction.

**Later symptoms—necrosis.** In more than 3,000 injections of 50 per cent dextrose solution not one slough was encountered. The solution, a few drops to 2 cubic centimeters, was inadvertently several times deposited outside the vein but in 2 days when next seen such patients presented no sign of necrosis not even an induration. The safety of the dextrose solutions is a great advantage even if the action of the vein is not as prompt as with more irritant substances. Since we have used the dextrose solution combined with 15 per cent sodium salicylate we have not encountered any difficulties but we believe that increased caution when using such a solution is advisable. Following the use of quinine a marked fibrosis was observed in some instances but no slough was encountered. Three small sloughs were encountered since the use of the dextrose sodium chloride mixture by a younger member of our clinic.

**Hæmorrhage.** We have not observed any external hæmorrhage. Not infrequently, however, a hæmatoma develops around the punctured vein, due to leakage of blood from the injured vein. This is particularly seen in women with soft poorly contractile vessels who show 'blue bumps' at the slightest injury. These small hæmatomata have no further significance and disappear after the visible transformation of blood pigment into biliverdin and bilirubin. The compression pad applied after the injection, will prevent a large hæmatoma and helps in the absorption of the existing ones.

**Embolism.** Up to the present time, we have not observed any case of pulmonary embolism either fatal or non fatal. Our attitude in this question has been discussed in a previous paper (7). Not only is the danger of pulmonary embolism much less than after radical excision but it is probable that varicose veins untreated may give rise to a pulmonary embolism in a small percentage of cases. Phlebitis *per se* as shown in Brown's statistics from the Mayo Clinic carries hardly an incidence of embolism. On the other hand operations that require prolonged immobilization



Fig 17 Isolated varix running in a transverse direction slight back-pressure. One injection of 5 cubic centimeters of 50 per cent dextrose effected a perfect cosmetic and functional result. After 1 year result was still the same

that prevent diaphragmatic and other muscular action, show the largest percentage of embolism. The fact that patients are ambulatory and that the thrombus is firmly attached and not loose as is a spontaneous thrombosis add a certain safety to the injection method. However, no such procedure can ever be entirely devoid of this danger. If one were to condemn a method for a possible incidence of embolism, fractures could not be reduced and splinted hernias could not be repaired.

#### INDICATIONS AND CONTRA INDICATIONS

As has been mentioned, injections are advised only if the varices are below the knee and if the reflux from the deep veins is not appreciable. If the long saphenous vein is distinctly palpable above the knee or if distinct dilatations are palpable the vein is tied at the highest palpable point. In case of very extensive varicosities both below and above the knee and particularly if there is a marked venous reflux, a radical operation is advised.

These indications have been followed in our clinic for the past 3 years. They are of course subject to change and are the result of our analyses of failures.

The injection treatment is contra indicated when the history or the test for deep venous return reveals an obstruction of the deep veins.



Fig 18 Varicose ulcer with marked involvement of the long saphenous vein. Injections and three applications of Unna's boot resulted in a firm healing of the ulcer. Such healed ulcers must be protected for several months from injury and carefully bandaged.

It may be quite possible and in *one case* we have definite evidence of it, that the deep thrombosis which brings on the superficial dilatations became compensated or otherwise overcome, so that the superficial veins could be removed without the slightest disturbance. Generally speaking the diffuse, hard oedema which is claimed by some authors to be of lymphatic origin (10-16) either prevents the injection of the superficial veins, or at least makes it unnecessary, as the oedema will not be benefited and the veins will refill from the deep circulation. Occasionally, an injection into a superficial vein may flare up an old deep phlebitis and result in oedema.

A superficial phlebitis, acute or subacute, contra indicates the injection treatment. If the infection still slumbers in the wall of the vein an injection may flare up the process. We had the opportunity to observe such a reaction in two instances, while the sudden flare up successfully obliterated the veins,



FIG. 19 Large varicose ulcer treated with pasteboots for 2 years previous to admission. The vein was radically excised because of the extent of varicosities and a full thickness graft was applied. Prompt healing took place.

such reactions are painful and alarming to the patient. If the patient is up and around and if the saphenous vein is ligated, no propagation of the clot must be feared.

In order to avoid such reactions, the rule should be followed that we observe in repairing a ventral hernia due to abdominal suppurations. For 6 months but preferably for a year, varicose veins should not be injected if there is a history of acute redness, swelling, and induration of the superficial veins. A chronic induration, however, even in the presence of an open ulcer is not a contraindication. We have injected veins above varicose ulcers in 75 instances without any reaction.

*Pregnancy and injection treatment.* Venous pressure in the lower extremities rises with the advance of pregnancy. Existing varicose veins are aggravated. They do not recede after childbirth but get progressively worse with each pregnancy. The question arises whether it is advisable to treat the veins during pregnancy or whether it is better to wait until after childbirth. Based on a small experience with pregnant women (6 cases) we found that the injection treatment gave them subjective relief and that if the main saphenous trunk was obliterated or ligated the progress of the disease could be stopped. This,



FIG. 20 Extensive varicosities both below and above the knee with marked reflux from the deep veins. Pressure is applied on the long saphenous vein above in spite of which marked tilting of the veins has taken place.

of course, is true only of the true varicose vein. If the deep circulation is obstructed and if the co-existing lymphatic block produces edema, the injection treatment is obviously not indicated and will not influence a postpartum phlegmasia. This important held-pregnancy and varicose veins—needs further investigation and study.

#### RESULTS

The figures given include the first 160 cases which were reported in a previous article (6). The total number of cases reported in this paper is 500. Of these 389 have received the entire course of treatment.

The average number of injections in any one patient is astonishingly low, due to the fact that several young women, especially in our private work, presented themselves early and were relieved very readily after a few treatments (Fig. 17). In these early cases the number of required injections varied between one and six and averaged roughly four. The more advanced the condition was and the more incompetent the communications between the long and short saphenous veins and between the superficial and deep veins, the higher the number of injections became. In a group of 100 such cases the average number of injections was 22. If ulcers were present the injection treatment was supplemented with pasteboot treatments of Linn.



Fig 21. Marked edema cyanosis and multiple livid ulcers following deep thrombophlebitis. The limbs were suspended vertically for 10 days. The ulcers on the right leg were excised, grafted and an extensive removal of subcutaneous tissue and fascia was performed. The ulcer on the left side healed during rest in bed. The leg was not operated upon. Six months after operation the induration and edema were far less marked on right side.

While the degree of involvement to a certain extent will enable us to determine the necessary number of treatments other factors such as the prevailing backpressure in the varicose vein, the degree of stagnation, the condition of the wall of the vessel should be considered. So it is impossible to tell the patient even approximately the necessary number of injections. It is also true that different patients respond differently to this treatment. In one patient every single injection produces prompt obliteration in a segment of several centimeters while in another patient seemingly in the same identical condition only repeated injections into the same segment will bring results. We have learned recently not to inject glucose into a partially obliterated vein as the parietal thrombi in such previously injected veins do not respond to glucose as readily as in a thin walled vein. For such cases glucose sodium chloride has proved to be effective.



Figs. 21, 22. Bilateral elephantiasis with necrotic spreading ulcers. The ulcers were infected. She refused hospitalization after a while and could not be followed.

The length of time for cure varied not only according to the degree of involvement but according to the number of visits made in a week and the number of injections during one visit. Therefore the average time required for cure, namely 2.94 months, roughly 3 months, cannot be evaluated without further analysis. Injections of glucose can be made every second day, two or three segments being treated at a time. However, most patients prefer not to come more often than twice a week and because of social reasons, the dispensary patient can hardly come more often than once a week. Also the number of injections given at one visit seldom exceeds two. The length of time for cure varies from 2 weeks to 9 months, the average is 3 months. The large number of ulcers treated makes the time unduly long.

An unusual opportunity was offered to compare these results with those obtained in 19 patients previous to the institution of the injection treatment. These patients had visited the surgical dispensary at earlier periods and had continued their visits after our clinic had started. The length of previous treatment varied from 1 year to 35 years, an average of 8.6 years. The average time required for cure under our management was 3½ months (Fig. 28).



With the reservations mentioned, we submit the immediate results of the injection treatment as follows

Total number of cases injected	389
Number of injections in a single case	1-35
Average number of injections in a single case	6.2
Length of time required for cure	2 weeks to 9 months
Average length of time required for cure	3 months

### FAILURES

The failures must be classified into immediate and late the late failures being the recurrences. Every case in which a permanent obliteration had not been obtained was classified as a failure. Recurrences could be observed as early as 6 weeks and as late as 1 year. While it was impossible to re-examine all discharged patients they were routinely asked to return every 3 months. It is probable that a comparatively larger number of patients with failures returned than of those cured.

The total number of failures in this series was 41.106 per cent, in 389 cases. The analysis of these failures was far more instructive to us than was an analysis of our favorable results. The cases which resulted in failures could be readily classified into the three groups, namely

- 1 Those with long saphenous veins wide open with incompetent valves so that the back pressure caused canalization of the thrombus (Fig. 16)

- 2 Those with large saccular dilatations with intima not intact and with extensive scar formation. In these cases the intima would not react to a bland stimulus (Fig. 14)

- 3 Those in which the Trendelenburg test was doubly positive indicating a reflux from the deep circulation as a result of incompetent valves in the anastomoses between the superficial and deep venous system (Fig. 15)

The logical means of overcoming failures in the first group is the ligation of the long saphenous vein at the highest palpable point. Under local infiltration anesthesia with one half per cent novocain adrenalin a short transverse line of incision is infiltrated with great care not to inject into the vein. The vein is exposed and cut between two No. 1 chromic catgut ligatures. To avoid damage to

the intima no artery clamps are applied on the vein. In this manner we believe it is possible to reduce to a minimum the possibility of the occurrence of a thrombus at the proximal stump of the vein. The skin incision is closed with a few stitches of interrupted dermal sutures on a straight skin needle. A compression bandage is applied with adhesive tape. The patient is allowed to go home immediately or if conditions would so indicate, is hospitalized for 24 hours.

Such ligations have been carried out in 61 instances, with no infection or bleeding in any of them. A thrombus of the proximal stump was palpable in 3 cases. A thrombus was found in the distal stump in almost every case. In two cases following the ligation a massive thrombus of the entire long saphenous vein occurred distal to the ligation. One patient suffered an extensive periphlebitis followed by a brawny induration, but the temperature remained normal. These patients were not hospitalized. The massive thrombosis resulted in a complete obliteration of the varicose veins. A latent infection must have been present in the wall of the vein at the time of operation.

Further experience is essential to determine how often massive thrombosis will follow ambulatory vein ligations. While such a reaction is not aimed at it may lead to a rapid cure of such varices as have been observed after trauma or after an acute superficial phlebitis.

As to the second group, invert sugar 75 per cent was the first of the stronger solutions used. The solution is thick which necessitates the use of large needles. This is an evident disadvantage. However the action of invert sugar is noticeably stronger than that of the 50 per cent dextrose solution and the reaction of the patient to it hardly any greater. Solutions of 60 and 50 per cent invert sugar have been tried and discontinued as no particular advantage over the 50 per cent dextrose could be observed.

A 10 per cent solution of quinine urethane produced rapid and satisfactory obliteration.

A solution of 50 per cent dextrose and 15 per cent sodium salicylate combined produces good effects while injected separately they

have been known to sclerose the veins. It is possible that the corroding effect of sodium salicylate, which is used in the combined solution in a comparatively weak concentration, is buffered by the thick sugar solution, which attracts a great deal of fluid and thus further dilutes the caustic agent. Clinically the solution causes a marked cramping, but a thrombus is promptly formed and there is much perivascular exudate. We reserve the use of this solution for large sclerotic veins that do not respond to treatment with sugar solutions. When used in large varicosities, it should be easier to avoid the danger of a perivascular injection. Because of the caramelization of the sugar in the alkaline sodium salicylate we have given up the use of this mixture and have substituted glucose sodium chloride.

In the third group, those with incompetent anastomotic valves, there is either an increased deep venous pressure or at least a continuous reflux from the deep circulation (Fig. 20). Clinically, these veins respond readily to injection, but the varices reappear very shortly, and can be obliterated only with great difficulty. The pressure in such veins is high even in the horizontal position, and they do not disappear when the patient lies down. However, there may not be an obstruction to the deep circulation—a fact which can be ruled out by the test of Perthes described.

In these cases with incompetent anastomotic valves, radical excision of the main trunk, with the lifting up of the tributaries from the fascia thus breaking the connections between the deep and superficial system, has given us the best results. In this series 16 such operations were done. Spinal anesthesia is preferable. Patients are not immobilized in bed and are allowed to get out of bed on the fifth day. Thus instead of trying to prevent embolism by the usual prolonged immobilization, we try to prevent thrombosis by early movements.

The use of thyroid extract to prevent pulmonary embolism has been suggested by Walters. In an obese woman with low blood pressure, the type of patient in whom embolism is to be feared, a very extensive Kondoleon operation was performed. She developed

a pulmonary embolism on the twenty first postoperative day which, however, did not end fatally. She received 6 grains of potent thyroid extract during the entire postoperative convalescence but could not be allowed to get up, because of the necessary elevation

#### COMMENT

The injection treatment of varicose veins has proved to be a valuable addition to our therapeutic armamentarium. If the cases are properly selected, the percentage of cures will certainly exceed those following radical surgery. Our oldest cure is now of 3 years' duration. However, judging from the end results following radical operations, the greatest percentage of recurrences takes place within the first 5 years after operation. The follow up records of the discharged cases are naturally of great interest, and for this reason every effort is being used to establish an accurate follow up system.

The advantages of the injection treatment are evident: the patient is not hospitalized, does not have to discontinue work, and suffers very little discomfort during the treatment. The danger of the injection treatment lies in the fact that it is easy to perform. However, if the cases are not scrupulously selected, the treatment will be discredited and again discarded, as has happened before in the past.

The ideal solution for the injection treatment has not yet been found. We believe that most of the solutions used are too irritant. Sodium chloride, sodium salicylate, quinine and urethane, all cause a great deal of cramping and the possibility of necrosis is always present. Fifty per cent dextrose is the least irritant and works very well in the non-inflamed, thin walled vein. By the addition of 15 per cent sodium salicylate, the efficiency of dextrose has been increased and yet we have reason to believe that the presence of the hypertonic dextrose buffers the sodium salicylate and the danger of necrosis is thereby diminished. Viscosity is another problem. If the solution were thinner, finer needles could be used.

The combination of preliminary ligations followed by injections has been very satisfac-

tory This method diminishes backpressure and prevents an ascending thrombosis We are aware of the objection—that the proximal stump itself may give rise to an embolism We have carefully palpated the site of ligatures in every case While the distal stump has very often shown a thrombosis and while in 2 cases a massive thrombosis distal to the ligation followed, the proximal stump showed a palpable thrombus in 2 out of 61 cases The patients are not immobilized, not hospitalized Most of them have lost but one day of work after ligation

We believe that the radical operation also has a very definite place in the treatment of varicose veins The reflux from the deep veins can be logically attacked only by interrupting the communications between the deep and superficial venous system If radical surgery is resorted to, it should really be radical The ligation of the saphenous vein should be done as high as possible, with an incision about two fingerwidths below and parallel to Poupart's ligament The stump of the ligated saphenous vein should be as short as possible The long saphenous vein can be stripped above the knee, but below the knee the main object of the operation is to interrupt all perforating veins This is far more important than the removal of an isolated dilated segment The operation is preferably done under spinal anesthesia, the patient is not immobilized longer than 4 to 5 days after the operation

Such operations are not frequently indicated In close to 400 cases it was performed 16 times an incidence of 4 per cent of the total number

Discrimination in the selection of cases for the injection treatment will bring the highest percentage of results

No mention has been made in this paper of the treatment of deep thrombophlebitis and of the thrombophlebitic ulcer, as the injection treatment of them obviously is not indicated The history of a sudden painful swelling following operations, infectious diseases or childbirth, and later of a persisting oedema and quite frequently of ulceration suggests such a diagnosis even without circulatory tests Collateral circulation, developing after deep venous block, may appear on the ab-

dominal wall or in the lumbar region and helps to diagnose the level of venous block

The prognosis as regards these disfiguring and painful swellings is not entirely hopeless The leg must be kept as free as possible from oedema by the prolonged use of an elastic support Six months after the initial attack careful massage and baking may be started We have seen slight rises in temperature and malaise even as late as 6 years after treatment and therefore advise massage which should be gradually increased in intensity If the limb has been allowed to remain water logged for a long period of time, the skin and subcutaneous tissue become so fibrous that even when the oedema has been removed the leg will not be able to regain its normal shape and size In extreme cases which may justly be called elephantiasis, a modified Kondeleon operation has been tried with encouraging results (Fig 21) In one patient, large, almost circular ulcers developed on the base of an old thrombophlebitis (Fig 22) Treatment consisting of vertical suspension sterilization of the ulcer, and full thickness grafts resulted in great improvement but the patient left the hospital before completion of the treatment and could not be traced

Some thrombophlebitic ulcers, if not too far advanced, may be treated with paste boots Such treatment results in a slow but firm healing and 6 months to a year later careful baking and massage may be started to loosen up the fibrosis

Patches of hyperkeratosis which develop on old ulcers must be treated with dermatological measures Itching eczematous skin responds very well to crude coal tar Shiny bright red weeping areas of eczema, which give the impression that the epidermis has simply been pulled off the surface are very painful and occur around varicose ulcers Paste boots are a most soothing dressing for them

Differentiation between the varicose ulcer from the thrombophlebitic traumatic luetic trophic ulcers and arteriosclerotic and diabetic gangrene is important not only from a prognostic standpoint but because the use of injections in varicose ulcers is not indicated, even if a few varices above the ulcers are present

Considerable use has been made of skin grafts. If the granulations show a healthy red appearance and if smears show a relative sterility they are shaved off with a flat razor and the graft is applied. Full thickness grafts and pinch grafts seemed to give better permanent results, although the percentage of takes was not so high as with Thiersch grafts. It is essential, however, to get rid of the oedema as much as possible before the grafting is undertaken.

#### SUMMARY

1 The management of 500 cases of varicose veins and their sequelæ is described. A thorough examination of the patient, ruling out conditions which contra indicate injections, is discussed.

2 Tests of arterial and venous circulation are described. Patients with beginning arterial occlusion or with obstructed deep venous circulation are excluded from treatment. The test for reflux from the deep veins is also significant.

3 The technique of injections and the solutions used are described together with the selection of the site and number of injections.

4 The histology of injected veins is briefly discussed.

5 The perusal of follow up records showed recurrences in 10.8 per cent of the cases. In such cases the persistence of increased pressure usually indicated surgical procedures such as ligation or radical excision.

6 The radical operation for varicose veins has been carried out in 4 per cent of the total number of treated cases. It is believed to have a limited but definite place in the treatment of varicose veins.

#### BIBLIOGRAPHY

- 1 BLACKFORD L MINOR The chemical obliteration of varicose veins J Am M Ass 1928 xci 1482
- 2 BROWN G E Postoperative phlebitis a clinical study Arch Surg, 1927 xv 245-253
- 3 BUERGER M The circulatory disturbances of the extremities Philadelphia and London W B Saunders Company 1924
- 4 CORNIL F and RANVIER Manuel d histologie pathologique Vol 1 p 626 1884
- 5 CURTIS, F Untersuchungen ueber das menschliche Venensystem Deutsche Arch f klin Med 1928 clxii 194-214 330-353 Klin Wchnschr 1928 vu, 2145-2146
- 6 DE TAKATS GEZA Varicose veins and their sequelæ J Am M Ass 1929 xcii 775-782
- 7 DE TAKATS GEZA QUINT H TILLOTSON B and CRITTENDEN P J The impairment of circulation in the varicose extremity Arch Surg, 1929 xviii 671-686
- 8 DE TAKATS, GEZA Ligation of popliteal vein for impending gangrene J Am. M Ass 1929 xcii 1264-1265
- 9 HANSELMANN MARGRIT Postoperative Thrombose Embolie und ihre Prophylaxe durch einen Preventivneigriff am Venensystem Dissertation der Univ Zurich 1926
- 10 HOMANS J and ZOLLINGER R Experimental thrombophlebitis and lymphatic obstruction of the lower limb Arch Surg 1929 xviii 902-907
- 11 KOSINSKI Quoted by de Takats (8)
- 12 LEWIS SIR THOMAS The blood vessels of the human skin and their responses London Shaw & Sons 1927
- 13 MCPHEETERS H O and RICE CARL Varicose veins, complications direct and associated following injection treatment J Am M Ass 1928 xci 2090
- 14 Idem Ulcer cruris the etiology pathogenesis and treatment Surg Gynec & Obst 1928 xlvii 469
- 15 MCPHEETERS H O and RICE CARL Varicose veins, complications direct and associated following injection treatment J Am M Ass 1928 xci 2090
- 16 MOSZKOWICZ LUDWIG Die Diagnose des Arterienverschlusses bei Gangraena pedis Mitt d Grenzgeb d Med u Chir 1907 xvii 216-227
- 17 REICHERT F L The regeneration of lymphatics Arch Surg 1926 xii 871-882
- 18 SICARD J A and GAUCIER L Traitement des varices Paris Masson et Cie 1927
- 19 STARR ISAAC JA Change in the reaction of the skin to histamine J Am M Ass 1928 xc 2092
- 20 STILLER B Die asthenische Constitution. Stuttgart 1907

BACTERIOLOGY AND PATHOGENESIS OF APPENDICITIS<sup>1</sup>ANNA H E DORSEY, BS MS ROCHESTER MINNESOTA  
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ROSENOW, Bagen, Nickel, Haden, and Bumpus and Meisser have shown that when streptococci freshly isolated from foci in patients who have certain diseases, are injected intravenously into animals, it is possible to produce, in a large percentage of the animals, the same disease as that from which the patient is suffering. The bacteriology of appendicitis and the elective localization of bacteria isolated from the appendix have been studied by Rosenow. He isolated streptococci and colon bacilli from patients with acute and with chronic appendicitis, and by injection of these cultures into rabbits he produced lesions in the appendices of a considerable percentage of the rabbits. In a second series of experiments, he was able to produce lesions in 70 per cent of animals which received injections with strains of organisms obtained from human beings with appendicitis. Rosenow and Dunlap found that cultures made from the tonsils of persons who had had appendicitis, caused appendicitis in 47 per cent of the animals which received injections of the cultures. This work of Rosenow and Dunlap was done during an outbreak of appendicitis in a military academy. Evans studied 236 cases of acute appendicitis in more than 16,000 students, and found that infection in the respiratory tract preceded the acute appendiceal attack by, on an average, 16 days. It was noted also that appendicitis most frequently followed the subsidence of acute infections of the nose or throat. Of the total number of students who had acute infection of the upper part of the respiratory tract acute appendicitis developed in only 1.5 per cent whereas an acute infection of the appendix developed in 3 or 3.5 per cent of the students who had this type of infection of the respiratory tract during periods when there were outbreaks of appendicitis.

Organisms other than streptococci have been recovered from the appendix removed at

operation. Thus, Dudgeon and Mitchner isolated bacillus welchii from material removed from the interior of the appendix. Cultured aerobically, it yielded either pure cultures of colon bacilli, mixed cultures of colon bacilli and streptococci, or staphylococcus albus and streptococci. More recently, Hatzegianu and Irimoinu were able to isolate the bacillus mucosus capsulatus enterogenes from 84 of 103 appendices from cases of appendicitis.

In view of the reported variation in the results of cultures in acute appendicitis it becomes apparent that in order to establish an etiological relationship of the organism to the disease, one must determine the results of inoculation of experimental animals with these bacteria. The work of Rosenow on the elective localization of bacteria in various pathological conditions, including his own studies on appendicitis suggested the present additional study of the bacterial flora isolated from the diseased appendix and from the throats of patients during acute attacks. In the attempt to throw light on the source of infection in the appendix, I studied the cultural characteristics of bacteria isolated from the appendices of patients who had undergone appendectomy and from the nasopharynxes of patients with appendicitis. Next, I studied the localizing power in animals of these bacteria. As a control, I made a similar study of bacteria obtained from the tonsils in patients who had arthritis. The part of the study that had to do with culturing of the original material will be related first. Cultures were not always taken from the appendix and the nasopharynx of the same patient, for the reason that the appendix was not available for culture in each case. The technique employed was similar to that used by Rosenow.

The material for cultures from the nasopharynxes of patients with appendicitis was obtained by swabbing the nasopharynxes

with sterile cotton swabs, at the time of, or within 24 hours after, appendectomy. The material on the swabs was suspended in 2 cubic centimeters of gelatin Locke solution and this suspension was introduced into tall tubes of glucose brain broth and glucose brain agar.

The tubes previously had been heated to boiling for 10 minutes to drive off the oxygen and subsequently were cooled to 40 degrees C. The tubes then were rotated vigorously to mix the contents thoroughly.

The tubes were sealed with sterile vaseline, all cultures were incubated for from 18 to 24 hours, and the primary, often mixed, culture was used for inoculation of animals.

The use of tall tubes of glucose brain broth and agar was suggested by Rosenow to obtain a wide range of oxygen tension in order to fulfill the oxygen requirements of various bacteria. It has been found that at the bottom of the tubes, adjacent to the piece of brain, methylene blue is decolorized and that the media are sufficiently anaerobic to grow tetanus bacilli. Also, the bacteria from the nasopharynx were planted on plates of horse blood agar.

The cultures from the appendices were made in a similar manner. As soon as the appendix was removed by the surgeon it was placed in sterile gauze and taken to the laboratory. If the appendix appeared acutely inflamed, some of the material from the interior was drawn into a sterile Pasteur pipette and introduced into tall tubes of glucose brain broth and glucose brain agar.

Usually one tube of agar and one tube of broth were sealed with vaseline to insure anaerobic conditions.

Further cultures were made directly from tissue of the appendices. Under sterile precautions, a portion of the wall of the appendix was cut off and placed in a tube containing 10 cubic centimeters of sterile physiological solution of sodium chloride, and this was shaken thoroughly. The tissue then was transferred into another tube containing sterile physiological solution of sodium chloride and this was repeated until the tissue had been washed three times. Under sterile precautions an emulsion was made of this

thoroughly washed tissue by grinding it in a mortar with sand and about 4 cubic centimeters of glucose brain broth. Approximately 1 to 1.5 cubic centimeters of this emulsion then was inoculated into tall tubes of glucose brain broth and glucose brain agar.

Since most of the cultures from the appendix yielded mixtures of streptococci and colon bacilli, since pure cultures of the streptococcus obtained by plating methods failed to produce lesions in the appendices of experimental animals, and since colon bacilli, if present in large numbers, usually killed rabbits from overwhelming infection before lesions of the appendix had time to develop, it was attempted to kill the colon bacilli by heating the inoculated tubes of glucose brain broth and glucose brain agar to 55 degrees C for 45 minutes in a water bath. Most often (and this is the preferable method) they were heated before they had been incubated, although in some cases the cultures were incubated from 18 to 24 hours and if a mixed culture of streptococci and colon bacilli was obtained, they then were heated. The culture then was plated to determine its purity or the relative number of colon bacilli that remained.

In the control cases of chronic arthritis, the cultures for injection of animals were obtained either from extirpated tonsils or from material expressed from tonsils *in situ*, by inserting a small laryngeal mirror between the tonsil and the anterior pillar and by applying pressure toward the base of the tonsil. By this means, material was expressed and by means of the mirror it was transferred to gelatin Locke solution. In the laboratory, the gelatin Locke solution was introduced into tubes of glucose brain broth and glucose brain agar and on blood agar plates. The 18 to 24 hour primary growth in the glucose brain broth was injected into animals.

#### RESULTS OF CULTURES

Strains of streptococci were isolated from the nasopharynxes of 13 patients suffering from acute, subacute, and chronic appendicitis. Of these cultures 9 were of nonhemolytic streptococci, and one was of a hemolytic streptococcus. In three instances the strep-

TABLE I—RESULTS OF CULTURES FROM THE APPENDICES AND NASOPHARYNGES OF PATIENTS WITH APPENDICITIS AND FROM THE TONSILS OF PATIENTS WITH ARTHRITIS

Source of culture	Cases	Organisms isolated
Appendices from 28 patients with acute appendicitis	23	Green producing streptococcus and colon bacilli (small non-walled)
	2	Streptococcus ataphylococcus and colon bacilli
	3	Green producing streptococcus (the men of the appendix)
Appendices from 25 patients with subacute and chronic appendicitis	16	Streptococcus and colon bacilli
	2	Streptococcus and ataphylococcus
	3	Pure cultures of streptococci
	4	Colon bacilli
Nasopharyngeal swabs from 23 patients with appendicitis	9	Non-haemolytic streptococcus
	3	Green producing streptococcus and Gram negative coccus
	2	Hæmolytic streptococcus
Tonsils from 22 patients with arthritis	22	Green producing streptococcus
	1	Green producing streptococcus and Gram negative coccus
	3	Hæmolytic streptococcus
	2	Streptococcus and ataphylococcus
	2	Hæmolytic and green producing streptococcus

tococcus was associated with micrococcus catarrhalis

Up to this point the cases of appendicitis have been mentioned as a group, without subgroups. In considering results of cultures and inoculation of animals, acute and chronic cases will be separated. The cultures obtained from the appendices in 28 cases of acute appendicitis consisted chiefly of streptococci and colon bacilli. The former were present in predominating numbers and were morphologically typical diplostreptococci and streptococci in short chains which grew readily in ordinary media after the primary growth had occurred under reduced oxygen tension in tall tubes of glucose brain broth. These streptococci produced green pigmentation or indifferent colonies on blood agar. Twenty-five of these cultures were from emulsions of the wall of the appendix, and of these 23 consisted of mixed cultures of streptococci and colon bacilli, and 2 cases yielded streptococci, staphylococci, and colon bacilli. The 3 remaining cases which yielded pure cultures of green producing streptococci were obtained from material from the lumen of the appendix.

Emulsions of the walls of 28 appendices in the cases of subacute and chronic appendicitis yielded the following results: streptococci

and colon bacilli were cultured from 16 appendices, streptococci and staphylococci from 2, pure cultures of streptococci from 3, and pure cultures of colon bacilli from 4. The three remaining cultures were negative. *Oxyuris vermicularis* was found in one appendix from which a pure culture of green producing streptococci was obtained. The indifferent streptococci were morphologically identical with the green producing streptococci.

The results of cultures of material from the tonsils of 22 patients with arthritis are mentioned in general in the section on results of inoculation of animals and are given in detail in Table I.

#### RESULTS OF INOCULATION OF ANIMALS

The number of strains and animals used in the inoculation experiments, the mortality rate, the incidence of lesions in, and the isolation of the streptococcus from the different organs following intravenous injection of the organisms that had been isolated in the different groups of cases are summarized in Table II.

Throughout this study, rabbits weighing 1,500 to 1,800 grams were given from 3 to 6 cubic centimeters of the original glucose brain broth culture by way of the marginal vein of the ear. Subcultures in glucose brain broth in a dosage of 7 to 12 cubic centimeters, were used for the two subsequent injections given on successive days to those animals that survived. The animals that withstood the effects of the injection were chloroformed usually at the end of 7 to 10 days after the first injection.

At necropsy, the organs were carefully investigated for gross lesions, and specimens of the heart's blood as well as material aspirated from the lumen of the appendix, mesenteric lymph nodes, kidneys, and joints, were introduced into glucose brain broth and spread on the surface of blood agar plates. Appendices in which there were gross pathological changes were placed in 10 per cent formalin to prepare them for microscopic section. These were stained for cellular changes by hæmatoxylin and eosin. Also they were stained for bacteria by the Rosenow modification of the Gram method which con-

TABLE II—ELECTIVE LOCALIZATION OF STREPTOCOCCI FROM THE APPENDICES AND NASOPHARYNGES OF PATIENTS WITH APPENDICITIS AND FROM THE TONSILS OF PATIENTS WITH ARTHRITIS

Source of culture	Strains	Animals injected	Mortality per cent	Percentage of animals showing lesions in							Percentage incidence of the isolation of streptococci from				
				Heart	Joints	Kidneys	Appendix	Mesenteric lymph nodes	Stomach		Blood	Joints	Kidneys	Appendix	Mesenteric lymph nodes
Appendices from patients with acute appendicitis	20	35	71	14	9	6	49	43	11	6	31	9	37	60	20
Appendices from patients with subacute and chronic appendicitis	20	30	60	10	13	10	40	20	7	7	20	13	30	63	20
Nasopharyngeal swabs from patients with acute subacute and chronic appendicitis	13	17	53	29	12	6	41	20	23	18	53	29	53	53	6
Tonsils from patients with chronic arthritis	22	31	39	19	51	0	10	6	16	0	26	45	29	16	6
Strains from patients with acute appendicitis after prolonged cultivation which produced lesions of the appendix on isolation	8	8	25	13	0	0	0	13	13	0	25	0	62	25	0

sists essentially of only partial decolorization after thorough staining in the gentian violet solution and fixation in Gram's iodine solution

First, elective localization of organisms from the appendix of patients with appendicitis was studied. Material from the lumens of these appendices was found to be unsuitable for this work. Therefore the organisms which were cultured for the purpose of obtaining a growth for injection were obtained from the walls of the removed appendices.

The elective localization in rabbits of organisms isolated from the appendix in 20 cases of acute appendicitis was studied in 35 rabbits. Pure cultures of streptococci were injected into 10 rabbits mixed cultures of streptococci and colon bacilli were injected into 24 rabbits, and in 1 case a mixed culture of streptococci, staphylococci, and colon bacilli was used.

Streptococci were recovered from the appendices in 21 (60 per cent) and lesions in the form of gross hemorrhages were found in 17 (49 per cent) of the appendices of these animals. The streptococci were obtained in pure culture in 7 instances and in association with colon bacilli in the remaining 14 positive appendiceal cultures. In 15 (43 per cent)

of the rabbits, there were marked hemorrhages in the mesenteric lymph nodes and in 7 (20 per cent) the mesenteric lymph nodes contained streptococci. In contrast to the predominating tendency of these strains of streptococci to become localized in the appendix of rabbits, is the strikingly less frequent localization of them in other organs. Streptococci were cultured from the heart's blood in 31 per cent, and in 37 per cent from the kidney. Thus, in only 4 of the 35 rabbits were there hemorrhages in the stomach and in 2, gastric ulcers, a total of 17 per cent of lesions in the stomach. Gross lesions occurred in the heart in 5 (14 per cent), and in 2 (6 per cent) in the kidney.

There was localization of streptococci in the joints of 3 (9 per cent) of the 35 rabbits which received injections. Included in this group is one rabbit which received intravenous injection with the emulsion of the appendix from a case of acute appendicitis. This animal lived 48 hours. At necropsy, performed shortly after death, hemorrhages were found in the appendix and mesenteric lymph nodes. Streptococci were obtained in cultures of the mesenteric lymph nodes, but cultures from the appendix, joints, and heart's blood did not yield streptococci.



Organisms obtained from the appendices in 20 of the cases of subacute and chronic appendicitis were injected into 30 rabbits. Pure cultures of streptococci were injected into 9 of these 30 rabbits. Mixed cultures of streptococci and colon bacilli were injected into 18 rabbits and in 3 instances only colon bacilli were injected. Streptococci were cultured from 19 of the 30 appendices (63 per cent). Gross lesions in the form of hæmorrhages were found in 12 (40 per cent) of the appendices. A pure culture of streptococci was obtained from 7 of the appendices, a mixed culture in 11, and only colon bacilli in 6. Hæmorrhages were observed and streptococci cultured in glucose brain broth from 6 (20 per cent) of the mesenteric lymph nodes. There were hæmorrhages in the mucous membrane of the stomach in 2 (7 per cent) and petechial ulcers in 2 (7 per cent). Three (10 per cent) of the animals had gross lesions of the heart and kidneys. Streptococci were cultured from the heart's blood in 6 (20 per cent), from the kidney in 9 (30 per cent), and from the knee joints in 4 (13 per cent).

The original cultures obtained from the nasopharynx in cases of acute and subacute and chronic appendicitis were injected intravenously into 17 rabbits. Of the cultures from the appendices 9 (53 per cent) yielded streptococci and there were hæmorrhages in 7 (41 per cent) of the appendices. Streptococci were obtained in pure culture from the mesenteric lymph nodes and in 5 (29 per cent) of these nodes there were hæmorrhages. Petechial hæmorrhages and ulcers were observed in the stomach in 7 (41 per cent). Streptococci were obtained from 9 (53 per cent) of the kidneys and in 9 cases from the heart's blood. Five (29 per cent) of the animals had slight hæmorrhages in the myocardium and in one there were gross lesions in the kidney. Swelling of the joints was noted in two rabbits and positive cultures of streptococci were obtained from the turbid fluid in 5 (29 per cent).

Cultures were made from the tonsils of 22 arthritic patients, and the primary cultures in glucose brain broth were injected intravenously into 31 rabbits. The material obtained directly from the tonsils, when

streaked on blood agar was found to consist, chiefly, of green producing streptococci, associated with smaller numbers of hæmolytic streptococci, *Micrococcus catarhals*, and staphylococci. Blood agar plate cultures, made from the primary culture of this material in glucose brain broth, when injected, yielded green producing streptococci only or green producing streptococci together with a few staphylococci.

Of these 31 rabbits, hæmorrhages of the joint developed in 16 (51 per cent) and there was swelling of one or more joints, or turbid fluid, in one or both knee joints. In 14 (45 per cent) of the rabbits, streptococci identical morphologically with those injected, were isolated in cultures of the joint fluid. Hæmorrhages were seen in 5 (10 per cent) of the appendices of 3 rabbits and streptococci were obtained from the appendices of 5 of them (16 per cent). There were gross lesions of the mesenteric lymph nodes in 2 (6 per cent), and from both streptococci were obtained in culture. Five (16 per cent) had hæmorrhages of the stomach but none had gastric ulcer. Streptococci were found in the heart's blood in 8 (26 per cent) and subendocardial petechial hæmorrhages in 6 (19 per cent). There were no gross lesions in the kidneys but the streptococci injected were recovered in culture of the kidneys in 9 (29 per cent).

Eight strains of streptococci from the appendices of patients who had appendicitis had been filed in meat infusion broth. That they had produced lesions in the appendices of rabbits was known. After a period of 10 to 12 months subcultures of these 8 strains in glucose brain broth were injected intravenously into 8 rabbits. Two of the animals were found dead at the end of 48 hours; the remainder were chloroformed, within from 2 to 5 days. Cultures made from the heart's blood contained streptococci in 2 cases and cultures made from the kidneys contained streptococci in 5 of the 8 animals. Growth was not obtained from the fluid from the knee joints or the mesenteric lymph nodes. Streptococci in association with colon bacilli were cultured from 2 of the appendices but these appendices were without lesions. Pe



Fig 1 Section of the appendix in a case of acute gangrenous appendicitis removed 24 hours after onset of symptoms. There are marked leucocytic infiltration beginning sloughing of the mucous membrane and oedema of the lymph follicle in the submucosa (Hæmatoxylin and eosin  $\times 60$ )

technical hemorrhages were found in the heart and stomach of one rabbit and in the mesenteric lymph nodes of another. Lesions were not observed in the joints or the kidneys of any of these rabbits

#### SUMMARY OF RESULTS OF EXAMINATION OF TISSUE

Although changes in tissue have been mentioned earlier in this paper it seems advisable to amplify this aspect of the work. The appendices were removed at operation early in the attack in nearly all cases of acute appendicitis. They presented the usual gross picture of marked congestion, with swelling of the wall and fibrinous exudation. In sections, marked leucocytic infiltration was found, usually, throughout the different coats and sometimes beyond the peritoneum. The mucous membrane often was necrotic and partly sloughed away (Fig 1). Search for bacteria was made in 13 sections. All of

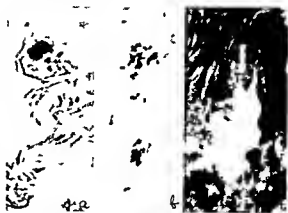


Fig 2 Diplococci in the tissues in 2 cases of acute appendicitis in man. a and b from lesions of the submucosa shown in Figure 1 c, from the serosa of another case of acute gangrenous appendicitis (Modified Gram's stain  $\times 800$ )

these, stained by the modified Gram Weigert method, contained diplococci or streptococci in short chains, in the peritoneal coat, the mucosa, or the submucosa (Fig 2). Gram

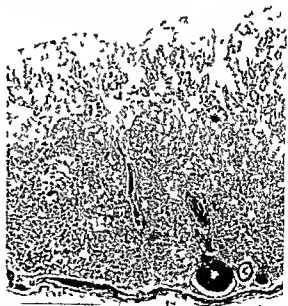


Fig 3 Section of the appendix of a rabbit in which there was marked evidence of hæmorrhage of the appendix and mesenteric lymph nodes 24 hours after an intravenous injection of a culture containing a marked preponderance of streptococci and a few colon bacilli. The source of the organisms was the wall of the appendix in a case of acute appendicitis. There were necrosis sloughing and cellular infiltration of the mucosa and submucosa (Hæmatoxylin and eosin  $\times 20$ )



Fig 4 Higher magnification of an area in the submucosa of the appendix from which Figure 3 was made. Polymorphonuclear leucocytes and large and small round cells are in varying states of disintegration. (Hematoxylin and eosin  $\times 400$ )



Fig 5 Longitudinal section of an appendix of a rabbit which 24 hours before had received an injection of a primary culture in glucose brain broth of material swabbed from the throat in a case of acute appendicitis. Marked edema, necrosis and cellular infiltration are present in the large lymph follicles, edema and cellular infiltration in the serosa and submucosa. (Hematoxylin and eosin  $\times 4$ )

negative bacilli, presumably colon bacilli, were found chiefly on the surface and in the superficial layers of the mucosa. They were never found in the peritoneal coat. Large gram positive bacilli, associated with fusiform bacilli and diplococci were seen in the peritoneal coat of two appendices. In many instances only individual cocci or single pairs of diplococci were seen (Fig 2 a and c). In other instances clusters of diplococci (Fig 2 b) were seen usually within large collections of lymphocytes.

In those animals in which there were lesions in the appendix the organ usually was found on macroscopic examination to be diffusely congested, swollen and edematous. However, there were no evidences of hemorrhages or purulent exudation in the serosa nor were there adhesions to the surrounding structures. The lumen usually contained mucoid or mucopurulent material, especially in the distal end which often was distended with exudate. Only occasionally was fecal material found in the proximal end of the appendices in which there were lesions, whereas in the ap-

pendices in which there was neither mucus nor lesions, fecal material usually was found throughout the whole length of the lumen. Fecal concretions similar to those seen in the appendices in human beings were not found in a single instance.

Hemorrhages of the appendices of the rabbits were found chiefly in mucosa, submucosa and immediately beneath the peritoneal coat. The number of hemorrhages varied from a few in one or more sharply circumscribed areas and mostly in the distal end to large numbers scattered throughout the entire appendix.

Studies were made of sections of the appendices of 22 rabbits in which gross lesions of the appendix appeared following injection of cultures made from the appendices or nasopharynxes of patients with acute, subacute, and chronic appendicitis. Microscopically,

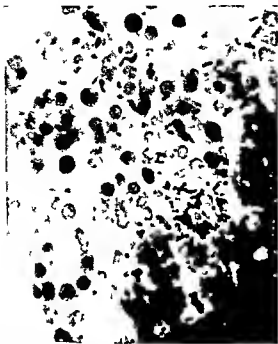


Fig 6 Large numbers of gram positive diplococci and a few bacilli in the area of necrosis shown in Figure 5 (Modified Gram's stain  $\times 1000$ )



Fig 7 Section of the appendix of a rabbit which 24 hours before had received an injection of the primary culture of streptococci made from material swabbed from the throat in a case of acute appendicitis. (Edema, necrosis and leucocytic and round cell infiltration extending especially throughout the mucosa, submucosa, lymph follicles and serosa (Hematoxylin and eosin  $\times 60$ ))

the lesions consisted, chiefly, of oedema, haemorrhage, and superficial necrosis of the mucous membrane (Fig 3), and necrosis in the centers of lymph follicles associated with relatively slight leucocytic infiltration (Figs 4, 5, and 6). Oedema and leucocytic infiltration (Fig 4) often consisting chiefly of eosinophiles were especially marked in the mucosa, in lymphoid follicles and beneath the peritoneal coat (Fig 7). The Gram stain revealed a variety of organisms: gram positive diplococci or streptococci resembling those injected intravenously (Figs 6, 8, and 9); gram negative bacilli resembling *Escherichia coli*, and large gram positive bacilli resembling *Bacillus subtilis* and *Clostridium welchii*. With one exception, only the gram positive diplococci or streptococci seemed to bear a causal relationship to the lesions found. At times masses of these were found in the centers of large regions of necrosis and of leucocytic infiltration (Figs 5 and 6). The gram positive and gram negative bacilli were especially numerous and diffusely distributed without regard to lesions in those animals that suc-

cumbed some time previous to necropsy. Diplococci or streptococci in short chains were found in lesions of the appendix in all but one instance, and this section was made from a region remote from the lesions noted at necropsy. The diplococci were found free in the mucopurulent material in the lumen and in the tissues where there was evidence of oedema, necrosis, or haemorrhage. They almost never were found in the normal tissues remote from lesions. They were present in large numbers in most of the sections although they were hard to find in others. They were successfully demonstrated in animals that were chloroformed or died from the effects of the injection and in which cultures from the blood, joints, and kidneys did not afford growth. Frequently, they occurred in nests especially within the lymph follicles in the lymphatic channels beneath the peritoneum of the wall of the appendix. They were found in sections as early as 24 hours and as long as 10 days after injection.

Sections were made and studied of haemorrhagic or oedematous mesenteric lymph nodes in 16 of the rabbits that showed evidence of

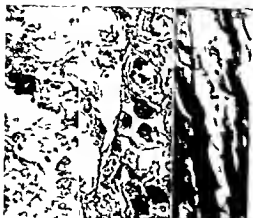


Fig 8 Diplococci in the tissues of the appendices of rabbits a and b from section shown in Figure 7 c from the appendix of a rabbit in which lesions in the appendix developed following intravenous injection with an emulsion of the wall of an acutely inflamed appendix of a human being (Modified Gram's stain  $\times 1000$ )

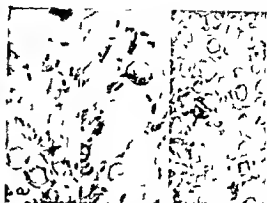


Fig 9 Diplococci in the hemorrhagic necrotic lymph nodes of two rabbits in which appendicitis developed following intravenous injection of streptococci from patients with appendicitis a and b from the rabbit referred to in Figure 7 c from a rabbit injected intravenously with streptococci isolated from the appendix in a case of acute gangrenous appendicitis (Modified Gram's stain  $\times 1000$ )

lesions in the appendix. The abnormalities found were similar to those found in the appendix. Diplococci or streptococci in short chains (Fig 9, a, b, and c) were demonstrated in all but two of these.

Examination of the appendix and mesenteric lymph nodes of 4 rabbits that received intravenous injections of cultures from the tonsils in cases of arthritis disclosed diplococci in only 1 appendix.

#### SUMMARY AND CONCLUSIONS

Streptococci isolated from diseased appendices removed at operation on human beings have a most striking resemblance morphologically and culturally to the streptococci isolated from the nasopharynges of patients suffering from appendicitis and to those obtained from tonsils of patients with arthritis. It would have been impossible, therefore, to determine the relation of streptococci isolated from either of these sources to the disease from which the patient was suffering unless animal experiments had been carried out. From my data it becomes clear that despite the morphological and cultural similarity of these streptococci their localizing power varied greatly. Thus a glance at the figures in Table II shows that the proportion of lesions in the appendices of rabbits and in the joints of rabbits varied with the

source of the material injected. When material derived from the nasopharynges or from the appendices of patients who had appendicitis was injected into animals the incidence of localization in the appendices of the animals was high. In these same animals the incidence of localization in the joints was low. On the other hand when material from the tonsils of patients with arthritis was injected into animals the incidence of localization in the joints of the animals was high and the incidence of the localization in the appendices low. This is entirely in accord with the observations of Rosenow in his studies on appendicitis and incidentally adds further support to the large mass of data which has been accumulated to substantiate the theory of elective localization.

It should be emphasized that the use of original cultures, either pure or mixed is an important factor in the success of studies such as this. This is brought out by the fact that cultures which had previously produced appendicitis lost their elective localizing power for the appendix after cultivation on artificial media for several months.

Diplococci and streptococci in short chains were successfully demonstrated by the modified gram stain in sections of appendices from human beings and in the appendices and mesenteric lymph nodes of rabbits.

The relation of focal infection to appendicitis is definitely shown by the marked contrast between the degree of localization in the appendices, of streptococci found in the nasopharynges of patients who had appendicitis and those who had arthritis. It seems, then, that streptococci more often than colon bacilli or other bacteria which are isolated from the diseased appendix have definite etiological significance in appendicitis that the nasopharynx may be the source of the streptococcus having this localizing power, and that appendicitis is commonly an hæmatogenous intramural streptococcal infection.

## BIBLIOGRAPHY

- 1 BARGEN J A Experimental studies on the etiology of chronic ulcerative colitis a preliminary report *J Am M Ass* 1924 lxxviii 332-336
- 2 BURRUS H C Jr and MEISSER J G Focal infection and selective localization of streptococci in pyelonephritis Study I *Arch Int Med* 1921 xxvii 326-337
- 3 DUBROV L S and MITCHELL P H The bacteriological and pathological examination of the vermiform appendix in the first thirty hours of acute appendicitis the space referred to the presence of fats in the wall of the appendix and lymphoid tissue *Brit J Surg* 1923-1924 xi 6,6-689
- 4 EVANS J S Epidemiology of acute appendicitis in relation to acute nasal and tonsillar infections *Wisconsin M J* 1918-1919 xvii 91-93
- 5 HADEN R L Lesions in rabbits following the intra-venous injection of bacteria from chronic periapical dental infection *Am J M Sc* 1926 clxxv 885-898
- 6 HATZEGANU I and IRIMIOIU Contribution à l'étude étiologique de l'appendicite *Arch d mal de l'appar digest* 1928 xviii 750-755
- 7 NICKEL A C The localization in animals of bacteria isolated from foci of infection *J Am M Ass* 1926 lxxviii 1117-1122
- 8 ROSENOW E C Bacteriology of cholecystitis and its production by injection of streptococci *J Am M Ass* 1914 lxiii 1835-1836
- 9 Idem The bacteriology of appendicitis and its production by intravenous injection of streptococci and colon bacilli *J Infect Dis* 1915 xvi 240-268
- 10 Idem Elective localization of streptococci *J Am M Ass* 1915 lvi 1687-1691
- 11 Idem Focal infection and elective localization of bacteria in appendicitis ulcer of the stomach cholecystitis and pancreatitis *Surg Gynec & Obst* 1921 xxxiii 19-26
- 12 ROSENOW E C and DUNLAP STELLA I An epidemic of appendicitis and parotitis probably due to streptococci contained in dairy products *J Infect Dis* 1916 xviii 385-390

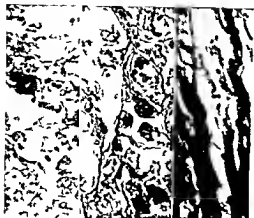


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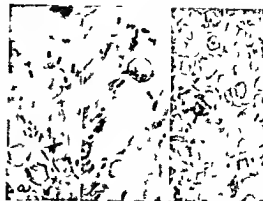


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It should be emphasized that the use of original cultures either pure or mixed is an important factor in the success of studies such as this. This is brought out by the fact that cultures which had previously produced appendicitis lost their elective localizing power for the appendix after cultivation on artificial media for several months.

Diplococci and streptococci in short chains were successfully demonstrated by the modified gram stain in sections of appendixes from human beings and in the appendixes and mesenteric lymph nodes of rabbits.

Muehsam (1900) ligated the appendiceal vessels of rabbits and obtained gangrene of the peripheral parts of the appendix. After ligation of the appendiceal vessels, appendicitis was produced by intravenous and intraperitoneal injections.

Adrian (1901) injected the streptococcus, staphylococcus, pneumococcus, bacillus coli, bacillus typhosus, bacillus tuberculosis, and bacillus anthracis into the blood stream and obtained follicular appendicitis. He concluded that the appendix was a particularly vulnerable part of the body.

Van Zwalenburg (1904) occluded the appendices of dogs by a ligature and injected fluid under high pressure into the appendix. He states "Experiments in dogs show that hydraulic pressure equal to the arterial tension maintained within the lumen of the appendix for a short time is promptly followed by typical appendicitis."

Richet and Saint Givans (1911) injected bacteria into the blood stream of rabbits and produced lesions in the appendix. The lesions were covered up by other lesions produced by secondary infection from the intestinal tract.

Heyde (1911) thought that anaerobic organisms played a very important role in the production of acute appendicitis.

Boit and Heyde (1912) and Sprengel (1912) considered stagnation as the most important factor in the production of acute appendicitis.

Heile (9) found changes in 6 of 100 appendices removed from apparently healthy dogs which resembled those found in man with acute appendicitis. He found that simple ligation of the appendix was followed by a restoration of the lumen, but he was able to produce what he considered complete occlusion of the lumen by the injection of paraffin into the wall of the appendix distal to a ligature which was tied very loosely. Complete occlusion produced in this manner never led to peritonitis or death but to localized abscesses at the sites of the injection. However if normal intestinal contents were placed in the appendix and the lumen occluded death followed in 1 to 5 days. Bacteria alone never caused destructive inflammation. Heile (10) was unable to confirm the work of the investigators who found that the infection of organisms in



Fig. 1 The relative positions of the initial incision and of the exteriorized appendix are shown in this drawing. In most instances a slightly greater length of the ileum and caecum were left attached to the appendix. In some experiments the wall of the intestine was not cut across just at the base of the appendix as is shown here.

to the blood stream led to severe inflammation. He was very careful not to traumatize the appendix. The injection of sausage into the ligated appendix led to destructive inflammation of its wall.

Rosenow (1915) injected into rabbits isolated strains of organisms which were obtained from human appendices and tonsils. He states "The results of the observations and experiments indicate that appendicitis, in the absence of foreign bodies, commonly is a hematogenous infection secondary to some distant focus, that it develops when, for some reason or other, the organisms in the focus, usually streptococci, have acquired an elective affinity for the appendix and at the same time gain entrance into the circulation."

Heile (12) as a result of experiments on more than 80 dogs could not confirm the origin of appendicitis by way of the blood stream. He believed that the neighboring colon with its varied bacterial flora made the origin of appendicitis from intestinal contents more probable. A normal appendix restored its lumen after ligation alone. A retention of bacteria in the appendix has never led to a



OBSERVATIONS UPON THE EXTERIORIZED APPENDIX OF THE DOG<sup>1</sup>

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SINCE the description of appendicitis by Fitz in the latter part of the nineteenth century much experimental work has been performed in an effort to determine the etiology of acute appendicitis. Studies have also been made upon the secretion of the appendix with particular reference to the enzymes which are present. In all of these studies, the appendix has either been left entirely in the peritoneal cavity or it has had its tip anchored to the anterior abdominal wall.

Dr. Florey, of the Department of Pathology of Cambridge University, was kind enough to demonstrate to one of us (A. B.) a method by which he exteriorized a small piece of the colon with its mesenteric attachment intact for the purpose of studying the changes in color of the mucous membrane during excitement. This together with experience with the exteriorized spleen as described by Barcroft and Stephens suggested to us the possibility of exteriorizing the appendix together with a small part of the ileum and cæcum. It was thought that this would afford an opportunity for making frequent observations after the various procedures had been carried out and that the secretion from the appendix could be collected without danger of intermixing with that from the small and large intestines.

## HISTORY

Rabbits have been used in most of the experimental work which has been done on the appendix. Rubbert (1883) tied off the appendix at the base and injected a culture of staphylococcus aureus into the tip. The animals were sacrificed after 3<sup>1</sup> hours and staphylococci were found in the follicles.

Roger and Josue (18) working on rabbits found that a wax ball would not remain in the appendix when placed there. Ligation of the appendix without including the appendiceal vessels produced no noteworthy lesion while if the vessels were included in the liga-

ture death followed after a shorter or longer time. Ligation of the appendix and the injection of a culture of bacillus coli resulted in death of the animals from suppurative appendicitis.

Beaussanat (1897) studied the effects on the appendices of rabbits of simple ligation of partial occlusion of the introduction of septic and aseptic foreign bodies with and without injury of the mucosa of intra appendicular and intra intestinal injections with and without injury of the mucosa, of infection introduced into the circulation with and without injury to the mucosa, of interfering with the circulation of the appendix with and without the injection of organisms into the vessels of the appendix of the intraparietal introduction of infection of the production of intestinal irritation by the feeding of badly infected meat and of the production of a blood stream infection when there had previously been inflammation of the intestinal tract. He came to the conclusion that appendicitis could be produced by blood or lymph stream infection but that more commonly it resulted from infection of the intestinal tract. Bacillus coli was the prevailing organism. He believed that the pathogenicity of the organisms was increased greatly by injury to the mucous membrane. He was not able to keep foreign bodies in the appendix and they were expelled.

Josue (1897) injected "strepto bacilli" intravenously in rabbits and obtained appendicitis without having traumatized the mucosa of the appendix. The same results were obtained after the injection of intestinal contents.

Anghel (1897) was unable to maintain foreign bodies in the lumen of the appendix of rabbits.

Gouget (1899) injected contaminated urine subcutaneously and as a result abscesses appeared at the site of the injection in the mesenteric lymph nodes in the spleen and in the appendix.

employed was not suitable for the detection of other enzymes, hence Heile digested the mucous membrane of the human appendix and found trypsin, amylase, and invertase. Lactase and maltase were absent.

#### METHOD

All of the experiments were performed upon dogs. Females were used because of the greater ease with which the dressings could be kept clean. The operation which was necessary for the exteriorization of the appendix was carried out as follows. An incision was made in the midline of the abdomen with the center of the incision at the level of the umbilicus. The appendix was then located and it was delivered through the incision together with the terminal ileum and proximal cæcum. After the intestinal clamps were applied the ileum was cut across about 4 centimeters proximal to the appendix and the cæcum was divided at an equal distance distal to the appendix. The mesentery was not disturbed. Either an end-to-end or a side to side anastomosis was then made between the ileum and cæcum, thereby restoring the continuity of the intestine. A stab incision was made in the right side of the abdomen at the level of the umbilicus. Care was taken to see that the stab incision was very near to the ileocecal region in order to avoid any tension on the mesentery. The appendix with the attached ileum and cæcum was pushed through the stab incision. The original midline incision was closed. In most of the experiments a longitudinal incision was then made through the walls of the exteriorized ileum and cæcum and the free edges were sutured to the surrounding skin. This left all of the mucous membrane exposed. In several instances, the wall of the intestine was left intact for a short distance just at the base of the appendix. The opening of the appendix into the ileocecal region was easily visible. Bleeding from the mucous membrane of the intestine was controlled by the sutures which held it to the skin. A large amount of sterile vaseline was placed over the mucous membrane and the appendix in order to avoid irritation by the dressing. A roll of gauze was then applied around the abdomen in a circular direction. A jacket which was made of cotton

cloth with perforations for the legs of the animal was then placed on and this was held in position by safety pins. Daily dressings were performed during the first week following the operation. The appearance of the preparation at the completion of the operation is illustrated in Figure 1.

The movements of the appendix and the reactions of the mucous membrane of the small and large intestine following stimulation were observed. Many attempts were made to block the lumen of the appendix by placing foreign bodies in it. The foreign bodies which were employed included balls of paraffin, cork, rubber balloons, and solid glass covered by rubber. Attempts were made to occlude the lumen of the appendix at its base by freeing one edge of the mucous membrane in this area and suturing it across the opening. In other instances, ligatures of catgut were placed around the base of the appendix without occluding its blood supply. In several experiments, the base of the appendix was occluded by a broad piece of tape which did not include the appendiceal blood vessels.

The secretion from the appendix was obtained by inserting the tip of a syringe into the lumen of the appendix at its base and making suction. The secretion was tested for the presence of invertase, maltase, crepsin, amylase, lipase, pepsin, trypsin, and lactase.

#### RESULTS

The peritoneum covering the appendix became quite reddened as a result of placing it outside the peritoneal cavity. There was very little alteration in the color of the mucous membrane. Approximately 2 weeks after an appendix had been exteriorized, it began to diminish in size slowly. The decrease in size was probably due to a constricting effect exerted by scar tissue which formed around the pedicle. In one appendix which had been exteriorized for 40 days and in another which had been exteriorized for 100 days, a perforation appeared in the tip. This again was probably due to a poor blood supply and the tip was the most vulnerable point. The microscopic appearance of an appendix which had been exteriorized for 40 days is shown in Figure 2. A ligature of catgut or silk, when



Fig 2 An appendix which had had its lumen occluded by a ligature of tape for 48 hours is shown in this photograph. The appendix was very much enlarged due to its being tightly filled with fluid and the peritoneal covering was quite red.



Fig 3 A photomicrograph showing an appendix which had been extirpated for 40 days. The low magnification was used in order to show the entire thickness of the wall. The appendix appears essentially normal except for the thick layer of fibrin on its peritoneal surface.

destructive inflammation of the wall with progressive peritonitis but at most to a local abscess formation in the lumen. However, if intestinal contents were imprisoned, a severe destructive inflammation of the walls with perforation took place and this resulted in peritonitis and death. The course of the inflammatory process was found to depend upon the amount of material present which was capable of being split down. The more of enzymes and unsplit proteins that were in the appendix the more rapid the inflammatory process, so that even 2 to 4 hours after beginning the experiment great alterations were found in the appendix. He further noted that if food which was fully digested was occluded in the appendix together with the usual intestinal flora no significant inflammation with tissue destruction resulted. Heile made the interesting comment that ordinary faeces at the junction of the small and large intestine did not lead to severe inflammation but that in diarrhoea and overeating more of the food passed undigested into the ileocaecal region. This was true of the protein in particular. He considered enteroliths dangerous only in that they contained unsplit proteins. However, he believed that occlusion was necessary, otherwise the peristaltic waves would carry away the toxins. He produced occlusion by placing strips of fascia around the appendix as well as

by injecting paraffin into the wall of the appendix. Microscopic examination of the appendices showed changes similar to those in acute appendicitis in man.

The studies upon the secretions of the appendix have not been numerous. Roger and Josue (19) demonstrated the presence of amylase in the appendices of rabbits by ligating the base and opening the tip. Strazesco (1904) made caecal fistulae in two dogs and found in the secretion in small amounts erepsin, amylase, maltase and invertase. He did not attempt to determine the secretions of the appendix alone. These secretions were found to be entirely independent of feeding as well as the composition of the food. Heile (11), working on dogs, performed an appendicostomy and so altered the base of the appendix that intestinal contents could not enter into it. Bags of gauze containing fibrin and cooked egg white were introduced into the appendix. Digestion took place indicating the presence of trypsin. The most active digestion took place 2 to 3 hours after meals. The method

employed was not suitable for the detection of other enzymes, hence Heile digested the mucous membrane of the human appendix and found trypsin, amylase, and invertase. Lactase and maltase were absent.

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placed around the base of the appendix with out occluding the blood supply, cut through after 1 or 2 days and the contents of the appendix were discharged through the perforation.

Every effort directed toward maintaining foreign bodies in the lumen of the appendix was unsuccessful. The peristaltic waves were extremely vigorous. The contractile power of the sphincter at the base of the appendix was very strong and it was only with difficulty that foreign bodies could be inserted past it. The secretion of the appendix was usually expelled in a spurt at the end of a peristaltic wave.

In another series of experiments the lumen of the appendix at its base was occluded by a broad piece of tape. The tape was so placed that it did not cause occlusion of the blood supply. A marked distention of the appendix followed in less than 24 hours as a result of the inability of the secretion of the appendix to escape. The appearance of the appendix was similar to that seen in hydras of the gall bladder. A photograph of an appendix which had had its lumen occluded for 48 hours by a ligature of tape is shown in Figure 3. After 2 to 4 days a perforation appeared in the wall of the appendix. The site of the perforation in all instances was slightly distal to the tape which had been placed around the base. In order to be sure that the extraperitoneal location of the appendix did not alter the results, several experiments were performed in which the appendix was left in the peritoneal cavity after a ligature of tape had been placed around its base. Alterations in the location of the appendix did not seem to change the results. An appendix which had had its base occluded by tape for from 2 to 4 days showed on microscopic examination the presence of fibrin on its peritoneal surface and leucocytes in the muscular coats.

The enzymes which were found in the secretion from the appendix were amylase, invertase, trypsin, and erepsin. Pepsin, lactase, maltase, and lipase were tested for but not demonstrated. The secretion consisted in the main of mucus. A few white blood cells and a few epithelial cells were usually found on microscopic examination.

#### DISCUSSION

The method of studying the appendix which is described here has both advantages and disadvantages. Chief among the disadvantages is the fact that an intraperitoneal structure is placed on the outside where it is subjected to irritation by the dressing. It also has the objection that there is a slowly progressive occlusion of the blood supply by the scar tissue which forms around the mesenteric attachment. It has the advantage that the appendix can be observed constantly in the essentially normal, non-narcotized dog. It allows one to collect the secretions from the appendix without danger of contamination by those from the remainder of the intestinal tract. It offers the opportunity for a study of the mucous membrane of both the large and small intestines in the unanesthetized dog.

Many investigators have failed in the attempt to block the lumen of the appendix of the rabbit or dog by placing foreign bodies in it. We were also unsuccessful in our efforts even though the appendix had been placed outside the peritoneal cavity.

The experiments of Van Zwalenburg in which he produced acute appendicitis in dogs have been mentioned previously. He injected fluid under very high pressure into the lumen of the appendix distal to a ligature which had been placed around its base. The experiments which are reported here in which a ligature of tape was placed around the base of the appendix produced a condition very similar to that reported by him. The inability of the secretion of the mucous membrane to escape produced a marked distention of the appendix with some evidence of acute inflammation.

If the appendix of man has as vigorous peristaltic waves as does that of the dog it is difficult to believe that acute appendicitis is produced simply by the lodging of a concretion in its lumen. It is possible that the escape of a foreign body which happens to be in the appendix is prevented by a concurrent swelling and edema of the mucous membrane. Here again if the contractions of the appendix of the human approach at all closely in strength those of the dog it is difficult to understand how the swelling could take place.

quickly enough to prevent the escape of a foreign body. It is possible that a difference in the strength of contractions may explain the frequency of appendicitis in man and the infrequency in dogs. The fact that the appendix of the dog is usually larger than that of man may also be a factor.

In summary, it is not certain whether appendicitis in man is or is not frequently the result of simple blockage of the lumen of the appendix. However, since a condition which simulates acute appendicitis can be produced in dogs by occluding the lumen by a ligature of tape and since the appendix of the dog is larger and probably has more forceful contractions, it is believed that some instances of appendicitis in man result from simple blockage of the lumen.

The enzymes which were found in the secretions from the appendix of the dog were amylase, invertase, trypsin, and erepsin. These enzymes have to do respectively with the splitting of starch to dextrin and maltose, with the changing of sucrose to glucose and fructose, with the conversion of the higher proteins to peptones and proteoses, and with the formation of amino acids from the peptones and proteoses. Heile (11) digested the mucous membrane of the human appendix and demonstrated the presence of amylase, invertase, and trypsin. The fact that three of the four enzymes which were found in the dog's appendix have been demonstrated in the human appendix suggest that the functions of the appendix in man and dog are quite similar. The copious secretion and the presence of the various enzymes lead one to think that the dog's appendix has to do with the digestion of food and not with the absorption of fluids.

SUMMARY

- 1 An operation has been described by which the appendix of the dog can be placed outside the peritoneal cavity.
- 2 Various attempts which were made in an effort to block the lumen of the appendix by placing foreign bodies in it were unsuccessful.
- 3 The occlusion of the lumen of the appendix at its base by a ligature of heavy tape results in a great increase in the size of the appendix with evidences of acute inflammation.
- 4 Amylase, invertase, trypsin, and erepsin were found in the secretions of the appendix.

BIBLIOGRAPHY

1 ADRIAN Mitt a d Grenzgeb d Med u Chir 1901 VII 497  
2 ANGEL Thesis de doct Paris 1897 No 276 p 42  
3 BARCROFT and STEPHENS J Physiol 1927 LXIV 1  
4 BEAUSSENAT Rev de gynéc et de chir abd 1897 1 283  
5 BOITARD HEYDE Beitr z klin Chir 1912 LXXIX 271  
6 FITZ REGINALD Am J M Sc 1886 XCII 321  
7 FLOREY H Personal communication 1928  
8 GOLGET A Compt rend Soc de biol 1890 LI 631  
9 HEILE Mitt a d Grenzgeb d Med u Chir 1910 XLV 58  
10 Idem Mitt a d Grenzgeb d Med u Chir 1913, XLVI 345  
11 Idem Beitr z klin Chir 1914 XCIII 520  
12 Idem Muenchen med Wchnschr 1925 LXXII 309  
13 HEYDE Beitr z klin Chir 1911 LXVI 1  
14 JOSUE Compt rend Soc de biol 1897 XLIX 280  
15 MUERSAN Deutsche Ztschr f Chir 1900 LV 143  
16 RIEBERT Deutsche med Wchnschr, 1885 XI 197  
17 RICHET and SAINT GIRONS Presse méd 1911 XLIX 271  
18 ROGER and JOSUE Rev de med 1896 XVI 433  
19 Idem Rev de med 1896 June Quoted by Binet and Dubois in Presse méd 1921 XLIX 625  
20 ROSENOW E C J Infect Dis 1915 XVI 240  
21 SPRENGEL Verhandl d deutsch Gesellsch f Chir, 41st Congress 1912 XL 247  
22 STRAZESKO Quoted in Malays Jahresb f Tier Chemie 1904 XXXIV 506  
23 VAN ZWALENBURG J Am M Ass, 1904 XLI 820

## TRAUMATIC ASPHYXIA

## WITH REPORT OF FIVE ADDITIONAL CASES

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**T**RAUMATIC asphyxia or traumatic cyanosis was probably first described by Olivier of Anvers in 1837 and later by Tardeu in 1870. In discussing the history of the study of this condition, Burrell and Crandon state:

'Classic and horrible examples of this are to be found in the rush of the mob at the Champ de Mars June 14 1837 where 23 persons were crushed, the Pont de la Concorde panic in Paris August 15 1866 where a mob crowded 9 of its number to death, the Vienna Ring Theater fire December 8 1881 with nearly 1000 fatalities the panic at Victoria Hall Sunderland, June 16 1883 where nearly 700 children rushed into a closed corridor and were asphyxiated by crushing and most recently at the Charity Bazaar fire in Paris May 4 1897.'

In the panic occurring in a ball park May 19, 1929 in New York City, two deaths occurred (Kennard). In each the evidence of asphyxia was pronounced. One was believed to have died from the asphyxiation incident to the pressure of the feet of the crowd upon the chest. The other had in addition fractured ribs.

Besides accidents that produce terror in large numbers of people with resulting panic, the industrial age has begun to claim traumatic asphyxia victims. Compression by elevators cranes, steam shovels, street cars, cow catchers, and wagon wheels may be mentioned. Mine accidents such as slate falls, compression between mine cars or between the mine top or side and a moving car have caused several cases. Perhaps the most unusual report we found was that of two sailors accidentally rolled as by a mangle into a ship's sail (Story).

It is interesting to note that since Heuer reported his case in 1923, 6 of the 11 cases of traumatic asphyxia described in the literature were caused by automobile accidents. One

of the 5 cases we are herein reporting was produced in an auto truck accident. The 4 remaining were coal mine injuries.

## INCIDENCE

Since first noted in 1837, many cases of traumatic asphyxia have appeared in the literature. Heuer in 1923 collected 127 cases including one of his own. We have found 11 more cases, a brief summary of each of which we include in this article. We have added 6 new cases observed by us in the past 2½ years in a series of over 37,000 hospital and clinic patients in an industrial field. Five other physicians in industrial practices in Southern West Virginia recalled out of approximately 75,000 major accident cases only 2 of traumatic asphyxia. These 2 cases have not been reported. This suggests that the condition is relatively rare or not always recognized. Modern textbooks on surgery refer to the subject very briefly, or make no mention whatever of it.

## CLINICAL SUMMARY

Although in his paper published in 1923 Heuer referred more particularly to the visual disturbances associated with traumatic asphyxia he has given the best clinical summary we have found in the literature. These patients present themselves with a history of immediately preceding severe compression of the thorax abdomen or both with complete or partial cessation of respiration for varying periods of time. The brilliant purple discoloration of the skin of the face, neck, and upper chest and the vivid blood red conjunctivæ present a truly startling clinical appearance. The characteristic lesion from which the condition receives its name is the skin discoloration which may be reddish violet or even black and covers the face, neck, upper chest to the level of the nipples, the upper arms to the insertion of the deltoid

muscles, and the back to the angles of the scapula producing the so called "double trapezius triangles." On close examination, the discoloration is seen to be due to minute ecchymotic spots so numerous as to appear confluent. The subconjunctival hæmorrhage may be extensive, and is usually lozenge (Robertson) or wedge shaped occupying the area of the exposed portions of the bulbar conjunctiva covering the sclera. There may be a marked bulbar and palpebral conjunctival œdema so that the patient is unable to close his eyes, which have the appearance of exophthalmos. There may be hæmorrhages from all mucous membranes. Unconsciousness occurs frequently. Convulsions and milder mental disturbances due to cortical irritation occur less frequently. The respiratory and cardiac functions may be markedly depressed. Ettinger noted cardiac dilatation and hæmaturia. Pulmonary congestion and œdema with other evidence of intrathoracic damage are revealed by hæmoptysis, blood tinged frothy expectoration, and bubbling rales, with elevation of temperature on the third or fourth day suggesting a "contusion pneumonia." This condition usually promptly clears up. Ecchymosis of the soft tissues about the site of compression, and fractured bones, especially the ribs and pelvis are noted. Hæmothorax, pneumonia, empyema multiple pulmonary abscesses, pleural effusion followed by empyema, open thoracic wounds, and subcutaneous emphysema have occurred. Associated abdominal lesions have been clinically rather uncommon. Contusions and lacerations of the soft tissues of the trunk, extremities, cord, peripheral nerves and fractured spines have been observed. Numerous eye changes have been reported including the subconjunctival hæmorrhage hereinbefore described, exophthalmos, proptosis oculi, pupillary changes, temporary and complete vision loss, retinal œdema, hæmorrhage into practically all portions of the eye, and optic atrophy. Death is usually the result of the more serious associated lesions.

#### PATHOLOGICAL PHYSIOLOGY

Green states that in addition to cessation of respiration in this condition, the venous

blood in the large veins of the thorax, neck, and head are forced backward into the capillaries of the skin. Perthes believed that the cause of discoloration is extravasation of blood, either minute or more extensive subcutaneous effusions or hæmorrhages. The peculiar limitation of the cyanosis he explained by the absence of functioning valves in the innominate and internal jugular veins except a pair where the jugular enters the innominate. These are irregular and incompetent. There are two pairs in the external jugular one at its junction with the subclavian and the other just above the clavicle. Both sets of valves are incompetent. We have noted in one of our cases that the cyanosis was less pronounced in the left face and neck than in the right. Huerter mentions the probable vasomotor paralysis with vascular distention as a factor in the production of cyanosis. Beach and Cobb removed two pieces of cyanosed skin under local anesthesia, and sectioning revealed no extravasation of blood into the tissues. This is corroborated, they believe, by the blanching on pressure and the rapid disappearance without passing through the various stages of discoloration as shown where blood is extravasated into the tissues. These histological findings were corroborated by Winslow and also in our study of one patient.

We have noted that in addition to its being the last to clear up the discoloration of the sclera passes through the various color stages of extravasated blood. We have attempted to shrink the vessels by applying 1:1000 dilution of adrenalin hydrochloride which has caused contraction only of the vessels at the margin of the discoloration. Pressure has produced no change. In 3 of our patients who recovered, we observed that the scleral discoloration was definitely wedge shaped, with the apices pointing toward the canthi. The remaining portions of the sclera above and below the iris were white and later became icteroid in color. We are unable to explain the wedge shaped discoloration upon anatomical arrangement of blood supply. We have noted the most intensely discolored portions of the sclera were those exposed to light and air, not being



covered by the eyelids. This is the same site in which pingueculæ are found. It is our belief that the eyelids help support the vessels and prevent their rupture in that portion of the sclera normally covered by the palpebra. This opinion is strengthened by the collar like band of almost normally colored skin around the necks of traumatic asphyxia patients described by Conwell and Coullie due no doubt to the skin being supported by the external pressure of the collar bands worn by the patients at the time of the injury. Similarly the skin beneath suspenders and hat bands has been reported normal. It is our belief that in traumatic asphyxia there is actual subconjunctival hemorrhage partially due to the lack of supporting tissue. Such hemorrhage is seen in old persons after straining or violent coughing and in children during whooping cough.

Normally a negative pressure exists in each intrapleural cavity. The elevation of the ribs and the pulling down of the diaphragm in inspiration increase the size of the intrapleural cavities and the pressure drops from minus 5 to minus 10 millimeters of mercury. This drop in pressure pulls apart the elastic structures in the thorax for example the lungs and the large veins thus exerting a sucking action on the blood flowing into the thorax through the large veins. In expiration the opposite obtains. The intrapleural space is made smaller and pressure rises. If further pressure is applied externally to the thorax as when a heavy weight such as falling slate in a mine is applied to the thorax, or if the chest is caught between two opposing forces and a squeezing action exerted, as when a miner is caught between two cars, the intrapleural space is made smaller and the pressure therein becomes positive. The degree to which this pressure may be raised must be tremendous. Macleod states that when 'the respiratory passages are blocked and a forced expiration is made, as for example in the first stage of coughing or during such acts as defecation and parturition, the thoracic cage is compressed upon the viscera with the result that the air in the lungs assumes a positive pressure, amounting to 100 millimeters mercury."

How much greater must be the positive pressure when the acting forces are not the patient's muscles, but the sudden vise like compression exerted by a ton of falling slate on one side and the unyielding rock floor of a mine on the other. It is easy to see how sudden reflux of the blood occurs with possible actual rupture of delicate vessels.

Concerning the production of this condition, Crile states that compression of the trunk produces traumatic asphyxia. Von Morian reports the case of a coal miner pinned across the thighs by a loaded car and held for 90 minutes, in whom the left leg for its entire length from a hand's breadth below the inguinal fold down to the malleoli was bluish in color due to innumerable small ecchymoses. The cyanosis extended above the zone of compression in the mid thigh, but at the zone of compression and in the foot the skin was not discolored. That the condition reported by von Morian is one of "traumatic cyanosis" there is no doubt. This suggests the advisability of using the term "traumatic asphyxia" to connote the cyanosis of the face, head, neck, and upper chest associated with compression of the chest and the upper abdomen when breathing is suspended for an abnormal length of time. The term 'traumatic cyanosis' could then readily be applied to a condition as described by von Morian. It is further advised that we use the term 'epileptic cyanosis' to describe the condition occasionally noted following a severe attack of grand mal epilepsy.

Coullie has recently reported a case of a white male, aged 28 years, subject to occasional epileptic seizures, who consulted his physician because of his deeply cyanosed face and bilateral subconjunctival hemorrhages. Seven months before, the patient had had a similar, but milder attack. There was a sharp line of demarcation at the level of the collar band. The case is described as one of traumatic asphyxia, the strangulating agent being the unyielding collar band operating during the congestion and partial asphyxiation of the epileptic fit. An account of the case was sent to the late Professor Harvey Littlejohn, of Edinburgh, who expressed the opinion that it was undoubtedly "a case of

so called traumatic asphyxia caused by the collar band compressing the jugulars, together with the partial asphyxia, high blood pressure, and fixation of the chest caused by the epileptic fit." The author further states that "so far as I can ascertain, my case is the only one on record which did not originate in compression of the chest and abdomen by external violence." Alexander, in 1909, reported a case of "stasis cyanosis" following an epileptic seizure, simulating traumatic asphyxia. This patient also wore a collar which was described as being tight, below which the skin was of normal color. Alexander quotes several other writers on the subject of hæmorrhage and cyanosis in epilepsy, stating further "I am inclined to believe that factors producing this condition are similar to those causing traumatic asphyxia, namely, a fixed thorax, a closed glottis, and increased intrathoracic pressure, a lack of aeration of the blood, and the incompetent and absent valves of the jugular, subclavian, and facial veins." In this connection, one of the authors has recently examined the body of an epileptic who had hung himself. There was a moderate degree of cyanosis of the face and neck. Above the skin compressed by the noose, the color was a faint violet. A section of tissue from the cyanosed area was examined histologically, and no evidence of change was noted except for probable dilatation of the capillaries.

Goldschmidt and Light have recently described "a cyanosis unrelated to oxygen unsaturation produced by increased peripheral venous pressure." They noted that when the arm is allowed to hang vertically from the shoulder and kept stationary, a greater or less degree of engorgement of the veins of the forearm and hand occurs. The skin of the hand, wrist, and lower part of the forearm takes on a bluish color of varying intensity. They present evidence showing that no marked increase in oxygen saturation of the venous blood occurs under these conditions. On the contrary, in the majority of cases it was either decreased or remained the same as the value obtained from blood drawn under conditions where the blue color of the skin was not present. They conclude that when

the arm is allowed to hang down and kept stationary the resulting engorgement of the capillaries and the venules may be a primary cause of blueness of the skin in the absence of an increase in oxygen unsaturation of the blood in these vessels that the immediate cause of dilatation of the capillaries and the subcapillary venules when the arm is hanging down is the increased hydrostatic pressure imposed upon the blood in the veins. There results in consequence an opening up and engorgement of the venules and at least a portion of the loop of the capillaries in the papillæ of the skin.

#### NECROPSY FINDINGS

Subdural hæmorrhage has been found by Olivier in a single case. Others have found no other cerebral change except congestion. The brain singularly escapes injury. The pulmonary changes noted have been œdema, congestion, apoplexy, hæmorrhage, ruptured lung, multiple abscesses, thrombosis, and bronchopneumonia. Increased fluidity of the blood, and subserous hæmorrhages occur. These hæmorrhages are customary findings in asphyxiated patients. Among the abdominal lesions noted have been hæmoperitoneum, herniæ, and rupture of various abdominal viscera. Bones are frequently broken especially the ribs, clavicles, extremities, jaw, pelvis, and vertebrae.

#### PROGNOSIS

The prognosis in this type of injury is exceedingly grave. Of the 5 cases we have seen, 2 died soon after admission to this hospital. The 3 others recovered and are living today. Unreported cases, no doubt, occur, intervening death or inability to recognize the condition precluding their report. Beach and Cobb state that the patients who live without the immediate aid of artificial respiration and oxygen will always be extraordinarily rare. Only 1 of the 3 patients who recovered in our cases had oxygen, and only 1 of them had artificial respiration immediately following the injury. Of the 143 cases included in this report, 27 were dead or died a few minutes after being seen. Of the 116 cases surviving the initial injury, 104

recovered and 12 died. Death is due to associated extensive injuries to important structures or to infectious complications.

#### SUMMARIES OF CASES IN THE LITERATURE

The following are brief summaries of cases reported in the literature since Heuer's collected series of 177 cases appeared in May 1913.

Davidson in 1922 reports the case of a boy aged 12 years who ran headlong into the radiator of an automobile. The youth was almost in *extremis* in a profound state of shock. There was cyanosis of the scalp, face, lips and neck. There was bilateral subconjunctival hemorrhage. The apitum was frothy (foam stained) and the patient developed a cough. A cellular emphysema of the neck and chest was noted. The right lung had collapsed and there was a forward dislocation of the sternal end of the left clavicle. Recovery was practically complete in 4 weeks.

Lawrence in February 1923 reports the case of a patient who in a wreck was pinned beneath the back of the front seat of an automobile. The patient regained consciousness 30 minutes after being removed from the wreck. The eyelids were puffy and red. The pupils reacted to light and accommodation. The forehead, face, neck to the shoulder points down to the sternal notch and in the trapezius muscle areas behind were of a peculiar bluish red cyanotic color with pale spots between. Other petechial areas resembled minute subcutaneous hemorrhages. The discoloration disappeared on pressure. Patient was discharged in good condition 12 days after admission.

Travers in March 1923 reported the case of a white male 47 years old who was squeezed for 30 minutes between the top of an overturned automobile weighing 3,000 pounds and the ground, the car resting on the lower part of his chest. The following were noted: cyanosis of the face and neck, protruding eyeballs, bulging conjunctivae, subconjunctival hemorrhages and epistaxis. Patient was pulseless and unable to see light until 12 hours after the accident. The blindness was believed to be due to hemorrhage surrounding the ocular nerve. There were fractures of the first transverse processes of the seventh, eighth and ninth vertebrae. About 3 months later vision of the right eye was 20/15 fundus clear left eye 20/25 slight change in both arteries and veins. Field of vision was contracted. Small central scotoma was present in the left eye. The disk was white.

Bager on April 15 1914 reported a patient whose chest was crushed between two cars and held for 1 minute. There was no loss of consciousness. Bager discusses the reasons for the retention of consciousness why blindness is common early with complete vision recovery as in his case in 2 weeks. He believes that the pre-existing pressure in the rigid skull and orbit evidently protect against the influx of blood during the compression.

Kunz in May 1924 reports that the trunk of a previously healthy man was squeezed down by an elevator. Severe and profuse stasis hemorrhage followed which developed evidently inside the skull as well as in the skin. This was relieved by lumbar puncture. The last trace of paralysis subsided by the end of the third month.

Connel in April 1926 reported that a male aged 41 years was pinned between an automobile and the ground. When examined 90 minutes later he was still unconscious. His head and neck were swollen and discolored a bluish black. Very soon the upper chest assumed the same color. There

were many striations of varying lengths on the anterior surface of the chest. The blue tint was due to stasis in the venules and to numerous punctiform hemorrhages or extensive ecchymoses. Tenderness was noted over the fourth and fifth ribs but fluoroscopy was negative. Normal color was regained in 10 days. The author observes that we must take into account both the passive agent and the active voluntary or reflex movements.

Conwell in January 1927 reports 4 cases. A male aged 22 years was pinned beneath a truck and suffered a fractured pelvis involving the superior ramus and the right pubis. He remained unconscious for several minutes. There was a definite strip of normal tissue at the base of the neck where the collar had been buttoned. The face and neck were cyanotic and severe bilateral subconjunctival hemorrhage was present impairing vision. The symptoms had disappeared in 2 weeks. The second was a white male aged 16 years injured in a similar manner. In addition to traumatic asphyxia he suffered an extensive skull fracture. He died 16 hours after the accident. The third a white male aged 22 years had the chest and abdomen crushed between a crane and a wall. He died 8 1/2 hours after injury. The fourth patient a female aged 22 years was injured in an automobile accident. She had marked subconjunctival hemorrhage in the left eye. There was a chip fracture of the right ulna in its upper third. The cyanosis had cleared up 12 days later except for the subconjunctival hemorrhage which had practically disappeared on the nineteenth day. Conwell states that convulsions are seldom present that the subconjunctival hemorrhage is invariable that death was probably never due directly to the asphyxia but to associated injuries.

Kosenblatt in June 1927 reported the case of a single white Polish laborer aged 30 years who was compressed against a stone wall by a steam shovel. He suffered great pain and shock. An indigo blue color appeared on the skin of the face, neck and upper portion of the shoulders. There was extensive bilateral subconjunctival hemorrhage. A double fracture line was present in the inferior ramus of the pelvis with displacement of the fragments with fracture of the superior ramus the second rib and with dislocation of the left clavicle. Patient was discharged 63 days after the accident and was well 2 months thereafter.

Von Monan in January 1916 reports an interesting case which we suggest should be called traumatic cyanosis. The patient a coal miner of 33 years was pinned across the thighs by a loaded car and held for 90 minutes. Neither wound nor fracture was found but there was complete paralysis of the right leg which disappeared in a few days. The left leg for its entire length was a bluish color due to unnumerable small ecchymoses beginning a hand's breadth below the inguinal fold and running to the malleoli hence above the zone of compression which was the mid thigh. At the point of pressure and in the foot no discoloration was noted. The cyanosis faded away in a fortnight.

Because of the absence of chest pressure and upper abdominal pressure with resulting circulatory disturbances within the thorax we prefer to call this a case of "traumatic cyanosis" rather than "traumatic asphyxia" and therefore have omitted it in this series.

The appearance of cyanosis of the face with bilateral subconjunctival hemorrhage in the male epileptic patient referred to





Fig. 1. Traumatic cyanosis in patient 3 days after accident showing, 1. hood red sclerotic cyanosis of head neck and chest with superficial abrasions of face and lower chest. The greater intensity of the cyanosis of the right face neck and chest is shown (a c c 2 No. B11 802)

*Traumatic Isophyllin*—William R. Timl and Milton C. Brown

previously as reported by Coullie in September, 1928, might be considered also as a case of traumatic asphyxia. We prefer to call this condition "epileptic cyanosis."

The 5 following traumatic cases were observed in a hospital service during the past 2½ years. This may appear to be a large group of cases for individual authors to report especially when it is known that the cases occurred singly. M. Ollivier, in 1837, reported a large series with 23 deaths occurring in the rush of a mob. Tardieu studied 30 victims of a panic of whom 9 died, as well as several cases of Professor Hardy's injured by a stampede produced by a falling wall. Ench Lange, in 1913, reported 7 cases. L. E. Robertson, in 1914, reported 6 cases. The next largest numbers reported are 4 by F. Voelcker in 1900, 4 by E. R. Ruppner, in 1904, and 4 by H. E. Conwell, in 1927.

**CASE 1.** No B9393. C. E. T. A white male mining engineer aged 35 years while riding on a mine motor was caught between the top of the mine and the car. He was not believed to have been rendered unconscious although there was practically complete cessation of breathing for several minutes. When rescued from his pinched position he presented an extremely dark purplish discoloration of the face, neck, and upper chest and marked bilateral ocular conjunctival hemorrhage. He was markedly dyspneic and had a brassy cough. He complained of severe pain in his chest. He was admitted to the hospital 2 hours after the accident. The cyanosis was still present. There were several superficial abrasions over the chest wall and upper abdomen. Despite rest, elevation, and the administration of morphine sulphate and digitalis the patient died 6 hours after admission. Necropsy was not performed.

**CASE 2.** No B11802. R. H. A white male 18 years old was caught in a slate fall in a coal mine. His body and extremities remained covered by a pile of slate during the 20 minutes required by co-workers to recover his body. He was alive but unconscious when admitted to the hospital 45 minutes after the accident occurred. He remained unconscious for 5 hours after admission. On admission his temperature was 98.2 degrees F, pulse rate 110, respiratory rate 22, blood pressure 140-60. There was marked cyanosis of the right half of the head, neck, and chest. The cyanosis was a diffuse bright purple. The sclerae were a brilliant blood red. The palpebrae were purple, the right being more intensely colored than the left and moderately edematous. The right ramus of the maxilla in its mid portion was completely fractured. There was a comminuted fracture in the upper third of the right femur. The cardiac action was unduly prominent.

the precordium heaving. The cardiac apex was visible and palpable in the fourth interspace 6 centimeters to the left of the midsternal line. There was a loud slapping systolic murmur, heard best over the apex. A crackling sound was heard over the fourth interspace to the left of the sternum. The second heart sound over the lower sternum was pistol shot clear and ringing in quality. During the height of inspiration breath being held the crackling sounds practically disappeared. When the breath was held at the end of expiration the sounds were intensified. Oxygen was given and external heat applied. Morphine sulphate hypodermically followed by elixir bromides and chloral hydrate in drachm doses were used thereafter to keep patient quiet and comfortable. The right lower extremity was placed in Buck's extension. Patient remained at rest for 2 months. On the third day after admission the discoloration of the skin became a dusky purple and at its margin on the chest there were small red punctate areas in the skin (See Fig. 1). One month after admission the cyanosis had completely cleared up except for the hemorrhage in the right sclera which was wedge shaped with the apices pointing toward the canthi. The labored cardiac action subsided at the end of the first week and the crackling sounds heard over the sternum disappeared at the end of the second week. Patient's urine contained large amounts of urobilin. The icterus index studied at repeated intervals during the 2 months of hospitalization revealed normal figures. The blood Wassermann was 2 plus the Weimcke was negative. The ophthalmoscopic examination was negative. X-ray of the spine revealed a compression fracture of the third and fourth lumbar vertebrae. Eighteen months after the injury when he returned he was still walking on crutches with paresis of the left lower extremity and left toe drop.

This case should teach a valuable lesson. Multiple bone fractures and especially fractures of the vertebrae should be suspected in every patient with traumatic asphyxia.

**CASE 3.** No B13480. L. J. Patient was a colored male aged 28 years a coal loader in the mines. While at work he was pinned beneath a large slate fall which his foreman stated weighed about 2 tons. Patient was completely buried beneath this slate which was estimated as varying from 1 to 2 feet in thickness. After about 20 minutes he was finally extricated when the slate had been elevated with jacks. He was unconscious and occasionally took a deep gasping breath. He was given one half grain morphine sulphate hypodermically. No artificial respiration was practiced or oxygen administered. It was believed that the patient would expire in a few minutes. There was marked cyanosis of the face, neck, and upper chest. During the day the patient gradually improved. His pulse became stronger the respirations became relatively normal.

and about 10 hours after the accident he was removed to the hospital. He was still unconscious. There was apparent exophthalmos with edema and hemorrhage in the conjunctiva and sclera. There was a dark purple discoloration extending over the upper half of the chest neck and right face. The blood pressure was 120/84, the cardiac rate 130, the heart sounds were subnormal in intensity but normal in duration and rhythm. Ophthalmoscopic examination revealed normal eyegrounds. Patient rapidly improved and was discharged from the hospital 8 days after admission. X-ray revealed no evidence of fractured ribs. Patient's blood Wassermann and Meinkes tests were both 3 plus. He gave a history of an apparently initial luetic lesion. Ten weeks after the accident patient had not returned to work. He occasionally spat up blood streaked sputum. His general physical condition however was excellent. The discoloration of the sclera had completely disappeared. Another ophthalmoscopic examination revealed normal retine disks and retinal vessels. Patient is living and well 5 months after the injury. X-ray of the lumbar and lower thoracic spine revealed no evidence of fracture.

CASE 4. No B13 728. R. F. H. The patient a white male 36 years old was driving a truck when its right front wheel collapsed and the truck turned over three times. No information could be secured as to whether or not patient was squeezed or unconscious. At the hospital 2 hours after injury examination revealed a mottled dusky purple discoloration over the face and ears extending to the lower margin of the jaw. The eyelids were edematous and purple and the sclerae were blood red in color. There was a punctate red mottling extending down the neck to a level about 2 inches below the clavicle. Ophthalmoscopic examination revealed normal fundi. Patient gradually became stuporous and died 3 days after admission.

Necropsy performed 2 hours after death revealed fractures of the first five right ribs in the right anterior axillary line with partial hemothorax. Emphysema of the subcutaneous tissues was present over the right pectoral and axillary regions. There was a right pneumothorax with broncholiths atelectasis of the right lung compensatory emphysema of the left lung a bronchopneumonia and passive hepatic congestion with pericholecystic adhesions. Each cusp of the aortic valve showed a normal free margin but an incomplete leaflet each leaflet giving the appearance of being perforated beneath its free margin. The left kidney weighed only 76 grams while its fellow weighed 220 grams. Histologically there was a bilateral renal congestion but no other change in either kidney. The spleen showed lymphoid hyperplasia.

CASE 5. No B13 777. A. H. Patient was a colored male coal miner 21 years old. Eleven hours before admission to the hospital he was wedged between a moving mine car and top of a mine. The motor was reversed and patient withdrawn. Artificial respiration was given. It was 20 minutes be-

fore patient breathed properly. He was unconscious for one half hour. On admission to the hospital the skin of the face and neck and upper chest down almost to the nipple line was dark purple in color. The sclerae were a bright blood red in color. Although there was considerable chest pain no fractured ribs could be demonstrated by physical examination or X-ray and no other evidences of abnormality were found. Five days after admission the optic disks and the retinae were examined and reported normal. One week after admission the only evidences of injury were the slightly discolored palpebrae and the blood red sclerae. A ressure applied to the sclerae produced no change. Adrenalin hydrochloride in a 1:1000 dilution produced apparent contraction of the vessels only at the margin of the scleral discoloration which in its mid portion was dark purple in color. This discoloration was wedge shaped on each side of the pupil with the apex of the wedge pointing toward the canthi. Above and below the pupils the sclerae were clear except for a definite keratoid tinge. Ophthalmoscopic examination was negative. Patient is alive and well 3 months after injury.

#### SUMMARY

In the foregoing paper on traumatic asphyxia we have presented a brief citation of various panics and public calamities resulting in traumatic asphyxia the different situations in our social and economic life reported as producing the condition, the incidence symptoms pathogenesis pathological physiology necropsy findings, and prognosis of traumatic asphyxia. The literature has been reviewed and the cases collected and briefly described since the date of Heuer's summary in May 1923. Five additional cases coming under our own observation during the past 2½ years are added making a total of 143 reported cases.

#### CONCLUSIONS

1. Although only 138 cases of traumatic asphyxia have been reported heretofore in medical literature it is probable that the condition is more frequently found than the literature would indicate.

2. Among the factors responsible for the morbidity of this condition are the occurrence of panics in large crowds, the collapse of structures seating or housing large collections of people, human negligence, our desire for speed, and the consequent use of machinery in industry and vehicles for rapid transportation.

3. The invariable subconjunctival hemorrhage noted in this condition has a peculiar

lozenge or wedge shaped distribution due probably to lack of supporting tissues

4 Unsuspected multiple bone fractures, especially fractured vertebræ, may be associated with the condition and may remain undetected in patients who recover unless thorough X ray study of the bony framework is performed

5 The probabilities of associated injuries to the abdominal and intrathoracic viscera must be remembered

6 The cyanosis noted in this condition is probably essentially due to capillary and venous dilatation and engorgement as revealed by histological studies and the recently reported studies of Goldschmidt and Light who have shown that cyanosis may be produced without change in the oxygen content of the blood

7 For the sake of accuracy and clarity, we suggest that the term "traumatic asphyxia" be applied to patients in whom there has been squeezing compression of the chest and upper abdomen with cessation of respiration for an abnormal length of time, with resulting cyanosis, subconjunctival hemorrhage, and the typical syndrome hereinbefore described, that local cyanosis, occurring for example in an extremity following local trauma or pressure be called "traumatic cyanosis", and that the rarely observed cyanosis developing in the face, neck, and upper chest during an attack of grand mal epilepsy be termed "epileptic cyanosis"

#### BIBLIOGRAPHY

- ALEXANDER E G A case of stasis cyanosis following an epileptic seizure simulating traumatic asphyxia *Ann Surg* 1909 xlix 762
- BAGER B Traumatic asphyxia *Hygiea* 1924 lxxvii 229-244
- BEACH H H A and COBS F Traumatic asphyxia *Ann Surg* 1904 xxxix 481-494
- BURRELL H L and CRANDON L R J Boston M & S J 1907 cxlvi 13-15
- CONWELL H E J Bone & Joint Surg 1927 ix 106-110
- COUILLIE A G Brit M J 1928 ii 569-570
- CRILE GEORGE W Keen's Surgery Philadelphia and London W B Saunders Company 1916 i 909
- DAVISON C Traumatic asphyxia rupture of lung dislocation of clavicle *Internat Clin* 1922 ii 10-16
- ETTINGER W Ein Fall ploetzlicher Kompression des Brustkorbes und Abdomens mit sekundärem Haemorrhagien Oedem und Zyanose des Gesichtes und Halses *Wien Klin Wchnschr* 1907 xx 665-667
- GOLDSCHMIDT SAMUEL and LIGHT ARTHUR B A cyanosis unrelated to oxygen unsaturation produced by increased peripheral venous pressure *Am J Physiol* 1925 lxxii 173
- GREEN THOMAS M Traumatic asphyxia *Surg Gynec & Obst* 1922 xxxv 59
- HEUER GEORGE J Traumatic asphyxia with especial reference to its ocular and visual disturbances *Surg Gynec & Obst* 1923 xxxvi 686
- HUEKTER C Deutsche Zeitschr f Chir 1874 iv 382-386
- KENNARD K SELLERS Personal communication
- KUNZ H Hemorrhage from compression of trunk *Mitt a d Grenzgeb d Med u Chir* 1923 xxxvii 235-242 Abstracted in *J Am M Ass*, 1924 lxxvii 1742
- LANGE ERICH Stauungsblutungen infolge traumatischer Rumpfkompensation *Deutsche Zeitschr f Chir* 1913 cix 76-136
- LAWRENCE C S Case of traumatic asphyxia *Vir ginia M Month* 1913 xlix 664-665
- MACLEOD J J R. Physiology and Biochemistry in Modern Medicine 4th ed p 323 St Louis The C V Mosby Company
- MORIAN VON Ueber einen Fall von Druckstauung Muenchen med Wchnschr 1901 xlviii 61
- OLIVIER (D'ANGERS) Relation Médicale des événements survenus au Champ-de Mars le 14 juin 1837 (3 cases examined after death) *Ann d hyg*, 1837 viii 485
- PETHES G Des extravasations sanguines étendues à la tete consécutives à la compression du thorax *Semaine méd* 1899 p 334 *Deutsche Zeitschr f Chir* 1898-99 i 436-443
- ROBERTSON L E Traumatic asphyxia with report of six cases *Canadian M Ass J* 1914 iv 501-507
- ROBERTSON W S A case of traumatic asphyxia *Brit M J* 1906 ii 1330-1340
- ROSMIT C Quoted by Graham *Gen Surg Prac Med Ser* 1917 p 337
- ROSENBLATT M S Traumatic cyanosis pathological physiology *Ann Surg*, 1927 lxxiv 802-807
- RUPFNER E Ueber Stauungsblatungen nach Kompression des Rumpfes *Cor bl f Schweiz Aerzte*, 1909 xxxix 45-56
- STORY WILLIAM A case of death from pressure *Lancet* 1863 ii 187
- TARDIEU AMBROSE La mort par suffocation *Ann d hyg* 1885 iv 371-441
- TRAYERS A H *J Am M Ass* 1923 lxxx 843-844
- VOELCKER F Vorläufiger Bericht ueber die Verletzungen bei der Heidelberger Eisenbahn Katastrophe *Deutsche med Wchnschr* 1900 xxvi 807-810
- WINSLOW RANDOLPH A case of so-called traumatic asphyxia *Med. News* 1905 lxxvii 207-208



# III INCREASED TOLERANCE OF PREGNANT RABBITS FOR INSULIN<sup>1</sup>

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**T**he following work represents part of an experiment that was instigated by the papers of Litus and his associates in which low blood sugar values and rapid fluctuations of the blood sugar level in eclampsia were reported. It was thought that the administration of insulin to rabbits during pregnancy by generally lowering the blood sugar level and by causing fluctuations in that level would result in diminished liver reserve and increased susceptibility to the strain of pregnancy. It was hoped that an upset in carbohydrate metabolism would lead to a syndrome in rabbits that would give a lead in the investigation of eclampsia or at least give some information concerning the carbohydrate changes in pregnancy.

During this experiment which was begun in December 1925 the rabbits were fed on a weighed diet consisting of 100 grams of oats, 100 grams of greens (lettuce, cauliflower leaves and celery), 100 grams of carrots and about 60 grams of alfalfa hay daily. Water was given *ad lib*. Insulin was administered subcutaneously.

The urine was tested for albumin by the nitric acid method. Frequently the heat and acetic acid method was used as well.

Blood sugars were determined by the micro method of Folin. The reagents were frequently checked and Folin's modifications and improvements were followed constantly.

**Experiment 1.** On the fifteenth day after being served doe rabbit No. 3 (weight 4.150 kilograms) received 10 units of insulin in two doses of 5 units each morning and evening. On the sixteenth day it received 12 units in the same way. The dose of insulin was thus increased daily so that on the thirty first day the animal received 32 units. It showed no evidence of any upset. By the nitric acid test the urine was consistently negative for albumin. The doe kindled normally the litter was normal. After kindling the doe weighed 4.335 kilograms.

Seven weeks later the experiment was repeated in exactly the same fashion the animal (weight 4.205 kilograms) not being pregnant. On the thirtieth day after it had received 39 units in the

previous 24 hours convulsions occurred. It died despite the administration of pituitrin and glucose. At autopsy the gross findings were negative. The microscopic examination of the uterus was negative with the exception of the thyroid which showed considerable atrophy. The liver was apparently normal.

**Experiment 2.** Rabbit No. 4 (weight 4.82 kilograms) not pregnant received insulin in increasing doses starting with 12 units (6 units morning and evening). It had convulsions on the tenth day having had 31 units in the previous 24 hours.

**Experiment 3.** Rabbit No. 6 (weight 2.7 kilograms) 22 days pregnant having fasted 16 hours was given 15 units. Twelve blood sugar tests during the next 6 hours were as follows:

(a) 90.9	(d) 65.0	(g) 45.8	(j) 55.3
(b) 56.3	(e) 56.5	(h) 42.5	(k) trace
(c) 60.0	(f) 49.7	(i) 30.0	(l) 31.5

There were no convulsions. It kindled normally the litter was normal. Five months later it received 16 units of insulin having fasted 16 hours. It was not pregnant and weighed 0.3 kilograms. Convulsions occurred in 3 hours and 8 minutes.

**Experiment 4.** Doe rabbit No. 13 (weight 3.123 kilograms) received 10 units on the tenth day of pregnancy, 6 units on the eleventh day and 4 units on the twelfth, thirteenth, fourteenth and fifteenth days. On the twentieth, twenty first, twenty second and twenty third days it received 24, 6, 5 and 35 units respectively. On the twenty fourth day having fasted 12 hours it received 16 units. Blood sugars during the following 6 hours were:

(a) 115	(d) 58.0	(g) 115.0
(b) 61.5	(e) 61.0	(f) 75.5

It received 16 more units that evening. The next morning (twenty fifth day weight 3.555 kilograms) food was withheld and 6 units were given. Mild convulsions occurred 4 hours and 34 minutes later. It delivered itself of a dead litter 80 hours and 19 minutes later after which it weighed 3.360 kilograms. At no time did the urine give a positive test for albumin.

**Experiment 5.** Doe rabbit No. 14 (weight 2.97 kilograms) received 10 units on the fifteenth day of pregnancy, 16 units on the sixteenth day (in two doses of 8 units), 18 units on the seventeenth day, etc. until the thirtieth day when the dose was 44 units. Blood sugars taken 3 to 3.5 hours after morning insulin were:

(a) 1st day 83.728	48.2	(d) 4th day 75.6	1.5
(b) 2d day 66.70		(e) 7th day 53	
(c) 23d day 87.65		(f) 30th day 78	

On the morning of the thirty first day the animal

<sup>1</sup>The help of an excellent internist, Dr. J. H. P. Smith, of the City Free Hospital, Boston, Brookline, Massachusetts, is acknowledged.

was found dead. The first fetus that had passed into the vagina was firmly wedged in the pelvis. There was no evidence of convulsions. At autopsy the gross and microscopic examinations were all negative.

*Experiment 6.* On May 31, 1929, doe rabbits No. 4, No. 8 and No. 18 not pregnant (weights 5.135, 4.515 and 3.545 kilograms respectively) and rabbits No. 12 and No. 17 (weights 3.605 and 3.520 kilograms) 19 and 26 days pregnant respectively all received 16 units of insulin, no food having been placed in their cages since the previous morning. All three non-pregnant animals went into convulsions; the pregnant animals were apparently unaffected despite the fact that they were smaller.

Since doe rabbit No. 3 had been receiving 10 to 18 units of insulin daily for 19 days before the actual start of the experiment and had had convulsions during that period its increased tolerance during the latter half of pregnancy seemed especially impressive. Rabbit No. 4, though larger and heavier, did not tolerate as much insulin as No. 3 under the same experimental conditions. In a number of other instances it was found that greater weight and size did not give one rabbit more tolerance for insulin than another. This fact makes definite conclusions almost impossible unless the reactions of the same rabbit while pregnant be compared to those while not pregnant.

In doe No. 6 the convulsive blood sugar level was remarkably low while pregnant; its blood sugar following insulin hovered around 30, the usual convulsive level in rabbits, and no convulsions occurred, while not pregnant its blood sugar 38 minutes before convulsions supervened was 31, at which time the level must have been considerably lower.

Although it was not determined exactly how much insulin would throw rabbits No. 3, No. 6, and No. 14 into convulsions during the latter part of pregnancy, it is probable that

they could have tolerated at least two or three units more which would have made the contrast more marked.

#### SUMMARY

Since the original plan in this experiment was to determine the effect of various methods of insulin administration on pregnant rabbits, no carefully organized effort was made to compare their tolerance for insulin with that of non-pregnant rabbits, and the above procedures are given more as suggestive evidence than as proof. At the start it was more or less assumed that pregnant rabbits would be more susceptible to insulin. Contrary to expectation they seemed to thrive during the experiment as did also the non-pregnant rabbits. Apparently in the latter third of pregnancy they can mobilize their glycogen more rapidly and completely or, what is more probable, can call upon their fetuses for glycogen in an emergency or depend upon them to utilize the extra insulin.

#### CONCLUSION

From the evidence at hand it is concluded that

1. Insulin cannot be related to the production of a toxemia of pregnancy in rabbits under the experimental conditions herein outlined.
2. Pregnant rabbits in the latter third of their gestation period have a greater tolerance for insulin than do non-pregnant rabbits.

#### REFERENCES

1. FOLIN, O. A new blood sugar method. *J. Biol. Chem.* 1928, **xxvii**, 421.
2. TITUS, P., DODDS, F. AND WILLETTS, F. W. Blood in eclampsia: fluctuations in blood sugar and its relation to convulsions: preliminary report. *Am. J. Obst. & Gynec.* 1927, **xiv**, 80-93.
3. *Idem*. *Am. J. Obst. & Gynec.* 1928, **xv**, 303.

# PRECONCEPTION OVARIAN IRRADIATION ITS INFLUENCE UPON THE DESCENDANTS OF THE ALBINO RAT (*RATTUS NORVEGICUS*)

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It is a well known fact that the ovaries and especially their follicular elements are peculiarly sensitive to radium and roentgen irradiation.<sup>1</sup> Furthermore a few defective and unhealthy children have been born after relatively prolonged exposures of the mothers to these two agents. The question has therefore naturally arisen as to whether the maternal irradiation has in any way been responsible for these disturbances of health and growth in the children.

Recent clinical studies by the author have summarized our knowledge regarding the health of the first generation of descendants from women receiving therapeutic ovarian radium or roentgen irradiation prior to conception (1936). On the basis of these studies it was concluded that such maternal treatment does not injure the health or growth of any subsequent children.

It could not be determined however whether or not the preconception irradiation caused any latent condition in the children—any damage which might be passed on to a succeeding generation and there appear for the first time. Information to this end was lacking because none of the children whose health was studied had as yet reached mature age. Since many heritable traits are known to skip one generation a further investigation was considered necessary especially in view of the importance of irradiation in gynecological practice and also because of certain conflicting observations which are the result of animal experimentation.<sup>2</sup>

## EXPERIMENTS

A group of virgin albino rats was selected and each animal subjected to a single radium

exposure of each ovary, prior to being mated. Those which remained fertile in spite of the treatment and their offspring form the basis for the present report. The investigation was concerned, mainly, with the health of the descendants of these animals and especially that of the second generation.

In planning the experiment the circumstances met with in practice, when women of child bearing age are exposed to substantiating amounts of therapeutic pelvic irradiation were duplicated as closely as possible. Mating was permitted only with non irradiated males and was delayed for a short time (14 days) following treatment. This postponement of mating was carried out in order that no ova which were in the oviducts at the time of irradiation should have an opportunity of becoming fertilized. It was desired that an ovum later to become fertilized should be in the ovaries at the time of the treatment. Furthermore according to Donaldson the life cycle of the rat passes with a speed which is 30 times more rapid than that of man. Therefore, a 14 day interval between treatment and mating of the former would be equivalent to 14 months in the case of the human.

For a number of reasons, the rat was selected for study. As it is a mammal, it structurally resembles man. Furthermore, it is small, reproduces frequently, and gives birth to many young at one time. In addition it is one of the best standardized of the smaller laboratory animals and—through the courtesy of the Wistar Institute of Anatomy and Biology—rats with a pedigree of many generations could be secured. This last feature was, perhaps, the most valuable for our purpose.

Virgin animals 120 days old were employed. It was desired that the first litters after irradiation should be the first born of the irradiated animals and, according to Duhning, the 120 day old rat is at its optimum breeding age.

<sup>1</sup> When referring to animal treatment the term "irradiation" applies to the use of radium. When referring to human treatment it applies to radium and the roentgen ray. By the expression "roentgen irradiation" is meant the therapeutic exposure—not the degree of exposure commonly employed for diagnostic purposes.

<sup>2</sup> The literature dealing with ovarian irradiation before fertilization was recently reviewed by the author (3).

TABLE I—FERTILE ANIMALS EXPOSED TO PRECONCEPTION OVARIAN IRRADIATION

Millicurie hours	Fertile animals
200	1
300	1
350	8
400	13
450	20
500	3
550	1
600	4
Total	51

TABLE II—AVERAGE INTERVALS IN DAYS BETWEEN THE CASTING OF THE FIRST AND SECOND LITTERS

Mother animals	Litters	Days between litters
Irradiated	23	48
Control	9	45.5

TABLE III—RELATIVE AVERAGE SIZES AND THE MOST FREQUENT SIZES (THE MODE) FOR THE FIRST LITTERS OF 51 ANIMALS WHICH RECEIVED PRECONCEPTION OVARIAN IRRADIATION, AND FOR 25 CONTROL ANIMALS

	Irradiated	Control
Number of animals	51	25
Average litter size	3.7	5.2
Mode	1	7

Note that the litters of the irradiated animals were smaller in size than were those of the control animals and that a single young was the most common litter size for the irradiated animals.

The minimum sterilizing radium exposure was first determined (5), in order to secure a standard by which a substerilizing exposure might be measured. When this had been accomplished, 50 animals were exposed to three-fourths of this sterilizing dose. Since some of them apparently were sterilized, even by this amount of treatment, other irradiated but fertile animals (used in the sterilization experiment) were included for study, in order to increase the total and because it was not known how any of the various dosages of radium used might affect the offspring.

Radium was employed because of its frequent use in gynecological practice and because a relatively large supply of this agent (2 grams) was available through the courtesy of the Cancer Research Committee of the medical staff of the Philadelphia General Hospital. The treatments were given in the Radium Research Laboratories of the hospital.

The radium was employed in the form of emanation now commonly termed "radon"

TABLE IV—RELATIVE AVERAGE SIZES AND THE MOST FREQUENT LITTER SIZES (THE MODE) FOR THE SECOND LITTERS OF 23 ANIMALS WHICH RECEIVED PRECONCEPTION OVARIAN IRRADIATION AND THE SAME RECORD FOR 9 CONTROL ANIMALS

	Irradiated	Control
Mother animals	23	9
Average litter size	4.6	5.4
Mode	3	4

TABLE V—AVERAGE SIZES OF FIRST LITTERS OF 51 IRRADIATED ANIMALS, ARRANGED ACCORDING TO THE AMOUNT OF MATERNAL TREATMENT DIRECTED AT EACH SINGLE OVARY

Millicurie hours	Litters	Average size
200	1	6
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Note that in a general way the longer the exposure the smaller the average litter size.

Its preparation and measurement and the calculation of dosages were carried out with the generous co-operation and assistance of Mr. Charles Robb, assistant physicist of the Philadelphia General Hospital.

Each animal received a bilateral ovarian irradiation, one exposure over each lumbar region, one ovary treated immediately after the other. The irradiation of the entire series of animals extended over a period of 6 months. The radium was measured before and after each group of animals was treated, as a check against the accidental breakage of the glass tubes containing radon during the course of the experiment.

The radium applicator was made in the form of a two piece brass capsule (Fig. 1), 2 centimeters in length and 8 millimeters in diameter, with a wall thickness of 2 millimeters, held to the animal's back by means of a bakelite bolder and adhesive plaster (Fig. 2). Further details of the technique are described in the paper on sterilization (5).

The subsequent offspring were examined and weighed the day of birth. The litter at that time was weighed as a whole. A similar weighing was made on the fifteenth day. Individual weighings were made on the

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The subsequent offspring were examined and weighed the day of birth. The litter at that time was weighed as a whole. A similar weighing was made on the fifteenth day. Individual weighings were made on the

TABLE VI—YOUNG OF IRRADIATED AND OF CONTROL ANIMALS AND THE AVERAGE WEIGHTS OF THESE YOUNG ARRANGED ACCORDING TO THE DAYS OF THE WEIGHINGS. THE AVERAGE WEIGHTS OF THESE YOUNG HAVE BEEN PRESENTED GRAPHICALLY IN FIGURE 5

Weight at times	1st litter of 51	2nd litter of 51	3rd litter of 51	4th litter of 51	5th litter of 51
At birth	155	4.25	234	5	
15 days of age	145	14.9	50	26.5	
30 days of age	135	15.6	2	11.4	
60 days of age	121	12	42	12.6	
90 days of age	102	8.5	25	8.2	
120 days of age	94	9.2	17	20.5	

thirtieth, sixtieth, ninetieth, and one hundred and twentieth days. On the thirtieth day the young were weaned and the sexes separated. On the one hundred and twentieth day the sexes, brothers and sisters when possible, in order to accentuate any inherited defect which might have resulted from the treatment were brought together again.

#### EFFECT OF TREATMENT UPON IRRADIATED ANIMALS

All of the irradiated animals exhibited marked local and general reaction to the severe treatment which they all received. The local reaction consisted of loss of hair over the treated area and this was followed in every case by severe ulceration of the body wall varying in extent and depth with the amount of exposure. In most instances the ulcerations finally healed although in some cases thick crusts persisted in the ulcerated regions and in several animals paralysis of the lower limbs was noted. The general reaction was manifested by a loss of weight in many instances amounting to as much as one fourth of the weight before treatment. In spite of the severity of the treatment none of the animals appeared to suffer in respect to their ability to reproduce. On the other hand the reaction to irradiation no doubt played an important role in affecting the health of the young prior to birth and the ability of their mothers properly to nurse them.

#### EFFECT ON FERTILITY

*Length of pregnancy.* Full term litters were cast by all of the 51 fertile animals (Table I)

TABLE VII—SUMMARY OF OBSERVATIONS

First generation of female young mated	36
Males mated 1 with the above	41
Female deaths during experiment	2
Under 30 days	3
Dying female, one litter before death	1
Number of animal, duration of mating period recorded	4
Longest period (in days)	709
Shortest period (in days)	51
Average period (in days)	111
Number of first generation in females casting litters	11
Number of litters cast by these animals	17
Intervals between mating and first litter casting for the first litters of these 11 animals	
Longest interval (in days)	218
Shortest interval (in days)	25
Average interval (in days)	10
Average interval for 17 control animals	37
Number of young cast by the first generation (17 litters)	91
Number of these 91 presenting gross abnormalities	6

Although abortion does occur very rarely in the albino rat, no instance was observed in the more than 100 litters cast after irradiation.

*One litter sterility.* Of the 51 fertile animals only 23 cast two or more litters. The irradiation appears to have been the most likely cause of the subsequent sterility in the remaining 28 animals. This high frequency of one litter sterility indicates the degree of irradiation to which these animals were subjected.

*Irradiation effect on the reproductive cycle.* The intervals between mating and the casting of the first litters of 51 irradiated and 17 control animals are presented graphically in Figure 3. Pregnancy in the rat lasts 21 or 23 days while insemination is possible once every 15 days (the length of the estrus cycle). The observations recorded in Figure 3 indicate that the greater number of the first litters of the 51 irradiated animals were conceived very shortly after mating. From this observation it appears that the estrus cycle when not completely inhibited by irradiation (as when permanent sterility is immediately produced) suffers no disturbance whatever. It further suggests that even heavy irradiation probably does not injure the ova which it does not destroy.

A similar study of the intervals between the births of the first and second litters of 23 irradiated animals leads to the same conclusions. In this group the interval between litters was longer than in the control animals (Table II).



Fig 1 Showing bakelite holders with hinged covers and brass radon-containing capsule *in situ*



Fig 2 Showing pair of bakelite holders in position for bilateral ovarian radium exposure. Note the partially concealed brass radon-containing capsule under the hinged cover on the animal's right side

Two or more litters were cast by the 23 animals just mentioned. In Figure 4 the intervals between mating and the casting of the first litters of these animals are contrasted with the intervals between the casting of the first and second litters. It will be observed here that the young of both groups of litters were practically all cast within 35 days of the mating or of the previous litter casting dates as the case might be.

#### FIRST GENERATION OFFSPRING

**Litter size.** A study of the litter size of the first generation young of the irradiated animals shows (Table III) that the irradiation decreased the number of offspring per litter. One young was the rule in the first litters of the 51 irradiated animals, while 7 young was the common litter in 25 control animals. The second litters of the 23 animals casting more than one (Table IV) were still smaller than the second litters of the control animals.

From a study of the litter sizes as influenced by the amount of the maternal treatment (Table V) it will be seen that in general the larger the amount of maternal treatment the smaller the size of the first litters.

**Mortality.** The 51 irradiated animals casting from 1 to 5 litters apiece more than 100 litters in all gave birth to 407 young. Of these, 39 were dead at the time of first observation while the death rate during the first month of life was very high among the remainder.

Many of the young animals were killed or eaten by their mothers shortly after birth. This was attributed to the ill health of the mothers which was the result of the local and general radium reaction, and also to the necessity of disturbing the newborn litters for examination and weighing.

**Bodily structure.** Of all the young live and dead, only one was deformed. It exhibited a clear cut case of hydrocephalus and was killed by the mother on the fifteenth day. Since this condition is not extremely rare in the experimental colony of the Wistar Institute the irradiation is not believed to have played an important role, if any, in its production. It may therefore be stated that, as far as could be determined by our study, no gross disturbances of bodily structure were observed which might be attributed to preconception irradiation of the subsequently fertilized ova.

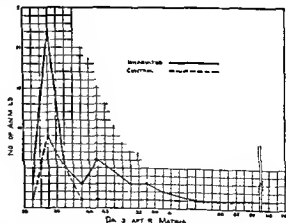


Fig 3 Two polygon curves demonstrating the relative speeds with which first litters were cast by 51 irradiated animals (uninterrupted line) and by 17 control animals (broken line).

The vertical line indicates the number of animals while the base line records the intervals (in 5-day periods) between mating and litter casting. Note that the greater number of the litters of both groups were cast within 35 days of mating.



TABLE VI—YOUNG OF IRRADIATED AND OF CONTROL ANIMALS AND THE AVERAGE WEIGHTS OF THESE YOUNG ARRANGED ACCORDING TO THE DAYS OF THE WEIGHTS. THE AVERAGE WEIGHTS OF THESE YOUNG HAVE BEEN TAKEN WITH CRITICALITY IN FIGURE 5

Weight taken	Young of irradiated	Young of control	Weight taken	Young of irradiated	Young of control
At birth	155	4.25	214	5	11.5
15 days of age	14	14.0	50	11.5	11.5
40 days of age	135	15.6	2	11.4	11.4
60 days of age	121	14	42	12.6	12.6
90 days of age	102	8.1	28	50.2	50.2
120 days of age	84	9.2	17	104.5	104.5

thirtieth sixtieth ninetieth and one hundred and twentieth days. On the thirtieth day the young were weaned and the sexes separated. On the one hundred and twentieth day the sexes, brothers and sisters when possible in order to accentuate any inherited defect which might have resulted from the treatment—were brought together again.

#### EFFECT OF TREATMENT ON IRRADIATED ANIMALS

All of the irradiated animals exhibited marked local and general reaction to the severe treatment which they all received. The local reaction consisted of loss of hair over the treated area and this was followed in every case by severe ulceration of the body wall varying in extent and depth with the amount of exposure. In most instances the ulcerations finally healed although in some cases thick crusts persisted in the ulcerated regions and in several animals paralysis of the lower limbs was noted. The general reaction was manifested by a loss of weight in many instances amounting to as much as one fourth of the weight before treatment. In spite of the severity of the treatment none of the animals appeared to suffer in respect to their ability to reproduce. On the other hand the reaction to irradiation no doubt played an important role in affecting the health of the young prior to birth and the ability of their mothers properly to nurse them.

#### EFFECT ON FERTILITY

*Length of pregnancy.* Full term litters were cast by all of the 51 fertile animals (Table I)

TABLE VII—SUMMARY OF OBSERVATIONS

First generation of female young mated	51
Males mated with the above	41
Female deaths during experiment	5
Under 30 days	2
Dying female—one litter before death	1
Number of animals—duration of mating period recorded	41
Longest period (in days)	209
Shortest period (in days)	51
Average period (in days)	111.9
Number of first generation females cast (no litters)	11
Number of litters cast by these animals	17
Intervals between mating and 1 litter casting for the first litters of these 11 animals	
Longest interval (in days)	218
Shortest interval (in days)	25
Average interval (in days)	10
Average interval for 6 control animals	31.4
Number of young cast by the first generation (17 litters)	91
Number of these 91 presenting gross abnormalities	1

Although abortion does occur very rarely in the albino rat no instance was observed in the more than 100 litters cast after irradiation.

*One litter sterility.* Of the 51 fertile animals only 3 cast two or more litters. The irradiation appears to have been the most likely cause of the subsequent sterility in the remaining 28 animals. This high frequency of one litter sterility indicates the degree of irradiation to which these animals were subjected.

*Irradiation effect on the reproductive cycle.* The intervals between mating and the casting of the first litters of 51 irradiated and 11 control animals are presented graphically in Figure 3. Pregnancy in the rat lasts 22 or 23 days while insemination is possible once every 3.5 days (the length of the oestrus cycle). The observations recorded in Figure 3 indicate that the greater number of the first litters of the 51 irradiated animals were conceived very shortly after mating. From this observation it appears that the oestrus cycle when not completely inhibited by irradiation (as when permanent sterility is immediately produced) suffers no disturbance whatever. It further suggests that even heavy irradiation probably does not injure the ova which it does not destroy.

A similar study of the intervals between the births of the first and second litters of 23 irradiated animals leads to the same conclusions. In this group the interval between litters was longer than in the control animals (Table II).

the 91 young exhibited any developmental defects, nor did the living ones, while under observation, present any evidence of injury which might have been attributed to the ovarian irradiation of their grandmothers. These second generation young were observed for a period of 4 months after birth.

#### RESULTS OF STUDY

In order more properly to evaluate the results of this experimental study, certain characteristics of the rat must be borne in mind. According to Donaldson the rat is approximately seven times more resistant to the ordinary poisons than is man. Also it normally presents few morphological abnormalities. These two characteristics indicate that we are dealing with an animal with a high degree of natural resistance.

From the local and general effects of the treatment and the relatively high frequency of one litter sterility, it is apparent that the ovaries of the irradiated animals were definitely affected. That no gross structural abnormalities were seen in any of the subsequent offspring is in accord with the clinical observations recently reported (2). Further, it was seen that the oestrus cycles and reproductive powers of the fertile animals seemed to be uninjured by the irradiation received. The truth of these observations seems to be substantiated by histological studies made upon the ovaries of these animals, which will be reported at a later date.

The disturbances in health and fertility observed in the offspring of the irradiated stock must be attributed, it is believed, to the systemic influence of the treatment upon the mother rather than to any specific influence upon the unfertilized ovum—at least until further experimentation shows this standpoint to be fallacious.

#### SUMMARY

1 A group of 51 albino rats was exposed to heavy ovarian radium treatments, before they were mated. Each of these animals later cast one or more litters.

2 The total first generation young amounted to 402. Of these, 17 females gave birth to 91 offspring (second generation), after mating

with brothers or with males born of other irradiated mothers.

3 No instance of abortion was observed in either generation.

4 In the irradiated animals either sterilization resulted or else the treatment did not materially alter the frequency with which subsequent conceptions followed one another.

5 Litter size was diminished by maternal ovarian irradiation, the earliest litters being the smallest.

6 The first generation young exhibited a delay in growth and fertility but presented no gross abnormalities which could reasonably be ascribed to the effect of the maternal irradiation.

7 Likewise the second generation of offspring showed no evidence of ill health or underdevelopment which might be attributed to the grandmaternal irradiation.

#### CONCLUSION

From this study no definite conclusion can be drawn in regard to the influence of preconception ovarian irradiation upon the health and development of the subsequent offspring of the albino rat. It is significant, however, that no gross structural abnormalities attributable to maternal ovarian irradiation were observed among 493 first and second generation descendants of a group of animals which received preconception ovarian radium irradiation.

#### REFERENCES

- 1 DONALDSON H. H. *The Rat*, 2d ed. Philadelphia: Wistar Institute, 1924.
- 2 DEURING F. LOUISE. Personal communication.
- 3 MURPHY D. P. Ovarian irradiation: its effect on the health of subsequent children. Review of the literature experimental and clinical with a report of 320 human pregnancies. *Surg. Gynec. & Obst.* 1928, *xviii*: 201-215.
- 4 Idem. Ovarian irradiation and the health of the subsequent child: a review of more than 700 previously unreported pregnancies in women subjected to pelvic irradiation. *Surg. Gynec. & Obst.* 1929, *xliii*: 766-779.
- 5 Idem. Radium sterilization of the female albino rat (*Mus norvegicus*). *Surg. Gynec. & Obst.* 1929, *xliii*: 440-445.
- 6 MURPHY D. P. and GOLDSTEIN L. Etiology of the ill health of children born after maternal pelvic irradiation. Part I. Unhealthy children born after preconception pelvic irradiation. *Am. J. Roentgenol.* 1929, *xxii*: 207-219.

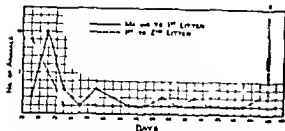


Fig. 4. Polygon curves indicating the interval in days before the casting of the first litters (uninterrupted line) and the interval in days between the casting of the first and second litters (dotted line) for 25 animals which had received preconception ovarian irradiation. The vertical line indicates the number of animals, while the base line records the intervals (in 5 day periods) between mating and the casting of the first litter in the one case and between the casting of the first and second litters in the other case, the animals having been constantly mated throughout this period.

Note that the casting of these 2 groups of litters occurred with relatively equal promptness.

**Growth rate.** The average weights of young of irradiated and of control animals as recorded at birth and during the succeeding 120 days are shown in Table VI. These have been graphically depicted in the 2 curves in Figure 5. It will be seen that the young of irradiated and of control animals grew with approximately the same degree of speed and that only during the last month of observation did there seem to be any appreciable degree of retardation in the growth of the young of the irradiated animals. It is believed that this retardation of growth was most likely the result of the general poor health of the mother due to the severity of her irradiation rather than to any specific effect of the irradiation upon the unfertilized ovum.

**Fertility.** At 120 days of age all female young were mated, with their brothers, if possible, but, if impossible then with other young from irradiated females. The summary (Table VII) of observations shows that 51 female young of irradiated parents, when mated for an average of 111.9 days, cast only 11 litters (21.6 per cent of fertility). Furthermore, the first litters of these young were cast on the average, 107 days after mating, while 17 control animals cast their first litters on the average, only 37.4 days after mating. These figures reveal that the first generation young of the irradiated stock were less fertile

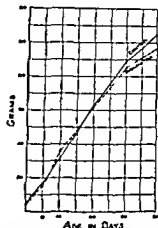


Fig. 5. Growth curves for 355 young born of irradiated mothers (dotted line) and for 234 young of control animals (uninterrupted line), based on weightings as recorded in Table VI. The vertical line shows the average weights in grams, while the base line records the intervals in days after birth at which times the various weightings were made.

than they should have been and that there was a considerable delay in the casting of litters.

A subsequent mating of these animals with males born of non irradiated stock was followed by a comparatively higher frequency of litter casting. However since the females in this later mating were older and larger than when first mated, this comparison is not very valuable. It suggests, however, that the young of the irradiated stock probably exhibited only a latent sterility, due to causes which are not very well understood. The delayed fertility may have been due to lack of early and proper nourishment, the result of the influence of the irradiation upon the mother, especially upon her mammary glands. That this delay in fertility may have been entirely due to the somewhat delayed growth of the young of the irradiated animals is suggested by the findings of Dr. Helen Dean King of the Wistar Institute. She has found that conception is rarely possible in female rats which, at 120 days of age, weighed less than 100 grams.

#### SECOND GENERATION OFFSPRING

The 17 litters cast by 11 of the offspring of the irradiated animals comprised a total of 99 young of the second generation, 67 of which were alive at the first observation. None of

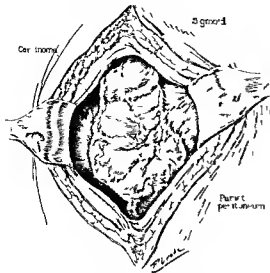


FIG 1 Abdominal incision exposing carcinoma of the sigmoid

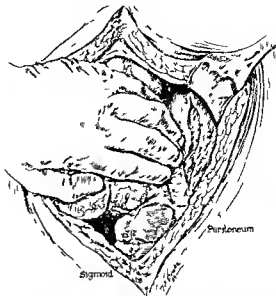


FIG 2 Beginning mobilization of neoplasm. Incision in the lateral parietal peritoneum which frees the growth and allows its rotation mesially. There are no blood vessels in this peritoneal layer.

After the employment of a type of pre operative treatment in all cases of lesions of the colon which resulted, in most instances in emptying the obstructed bowel to such a degree that it approached normal size, I began to perform a type of resection, similar to the procedure in which the first two steps of the exteriorization are performed in one step, but far more radical. It enabled me to remove not only all of the mesentery desirable but the tissues in immediate juxtaposition to the growth, to peritonize the raw surfaces to insure the blood supply to the two ends of the bowel and to leave the bowel obstructed for 48 to 72 hours with impunity. All this was possible because of the thorough pre operative cleansing and concomitant reduction of local infection. The technique of such obstructive resection I believe employs the admirable principles of the procedure of exteriorization and at the same time, obviates undesirable features and a high rate of mortality. Although it has not been noted so far as I know the Mikulicz procedure carries a higher operative mortality than any other type of resection. This obstructive type of resection I have employed as a routine in the last year as the operation of choice for all lesions in mobile segments of the large bowel. From January 10, 1929, to November 22, 1930 I performed 31 obstructive resections of the colon with a single fatality. The man who died was aged 64 years, he was of short and heavy build so that the operation was technically difficult. He died 36 hours after the operation from a pulmonary embolus.

The indications for obstructive resection are the same as those for the Mikulicz operation, and I believe they may be extended considerably. The pre operative preparation that is made as a routine has lessened the infection of growths of the colon and has left the colon itself free from obstruction or only slightly obstructed, and thus has promoted extension of the operative attack to conditions which otherwise would have been approached by different technical steps. The indications for this operation are the presence of a mobile growth in any segment of the bowel and one which on the basis of experience and clinical judgment, is deemed not too infected or too much attached to surrounding tissues to prevent its resection. The contra indications to procedures of exteriorization, as laid down by Sistrunk at a recent meeting of the American Surgical Society, are as follows: (1) cases of adherent growths associated with infection of the wall of the bowel and adjacent tissues, (2) large growths associated with infection, (3) growths associated with obstruction, and (4) growths in the sigmoid colon with a short mesentery in obese patients, with thick abdominal walls. I heartily concur in these contra indications. My feeling is that the original type of Mikulicz procedure is most aptly applied to a small annular, scirrhous growth in a mobile segment of colon in an elderly patient, who is unable to withstand an extensive opera-

# CLINICAL SURGERY

FROM THE MAYO CLINIC

## RESECTION AND OBSTRUCTION OF THE COLON (OBSTRUCTIVE RESECTION)<sup>1</sup>

FRED W. KANKIN, M. D., ROCHESTER, MINNESOTA

In Association with The Mayo Clinic

**I**NTESTINAL resection in multiple stages as an emergency measure had been performed by surgeons for many years before Block in 1892 first suggested the employment of this method as a deliberate maneuver in the eradication of a malignant neoplasm of the large bowel. Shortly thereafter the operation of exteriorization became popularized by Mikulicz and Bruns and was hailed as a radical advance in surgery of the colon. The operation as performed by these men and as described in a system of practical surgery by Bergmann, Bruns and Mikulicz differs somewhat from the modifications which have been introduced in this country, but the principles of bringing the bowel to the outside without opening its lumen and of subsequently removing the offending segment remain the predominant features.

This procedure was uniformly acceptable because of the theoretic possibilities it offered. Unquestionably the underlying fundamental principle of resection in multiple stages without incision of the bowel at the initial step was admirable. The theory of lack of peritoneal contamination from exteriorization although ideal failed to take into account the contamination from exploration and mobilization of the growth which subsequent endeavors so frequently have proved to take place. My experience is that contamination comes not so much from the open operation as from the handling of the growth during its mobilization or during the necessary exploration of the abdominal cavity. Infection is spread because of the thinness of the wall of the bowel under manipulation and the already existing contamination in the pericolic tissues and adjacent lymphatic channels as frequently has been demonstrated by numerous observers.

Experience has proved that this procedure as originally described had certain definite drawbacks, the most prominent of which was the

likelihood of direct transplantation of malignant cells into a cut wound when the growth was brought out in the original incision. This actually occurred in 1 per cent of the cases in which operation was performed by this method in The Mayo Clinic despite the fact that numerous and various attempts were made to preclude its occurrence.

Another disadvantage was the limitation of application of the principle unless extensive mobilization were effected and the frequent necessity of ligating the blood supply in order to render the tumefaction extraperitoneal. After the blood supply had been ligated one not infrequently was confronted with a serious problem, namely the development of necrosis and gangrene in the exteriorized growth with subsequent contamination from direct extension. Furthermore resection of the loop was frequently demanded in the first 48 hours after the primary stage of the operation and contamination took place by direct extension because of poor healing power, and the attendant dehydration and desiccation from which many of these patients suffered. Occasionally as an emergency measure the first two stages of the operation were performed at one step, clamps being left on the ends of the bowel thus obstructing it until peritoneal coaptation had taken place when the proximal end could be opened itself. This I found on looking up the records however was a step which was accompanied by higher mortality than the other type of procedures employed evidently because of the type of case in which it had been undertaken. However it occurred to me that any operation in which recurrence of the malignant condition in the abdominal wall took place in 1 per cent of cases either should be abandoned or modified to correct this defect and yet the admirable features of the Mikulicz operation were theoretically and fundamentally sound.

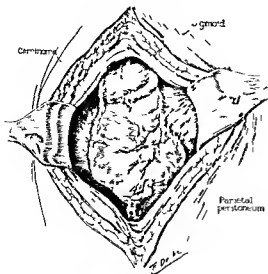


Fig. 1 Abdominal incision exposing carcinoma of the sigmoid

After the employment of a type of pre operative treatment in all cases of lesions of the colon which resulted, in most instances, in emptying the obstructed bowel to such a degree that it approached normal size, I began to perform a type of resection, similar to the procedure in which the first two steps of the exteriorization are performed in one step, but far more radical. It enabled me to remove not only all of the mesentery desirable but the tissues in immediate juxtaposition to the growth, to peritonize the raw surfaces to insure the blood supply to the two ends of the bowel, and to leave the bowel obstructed for 48 to 72 hours with impunity. All this was possible because of the thorough pre-operative cleansing and concomitant reduction of local infection. The technique of such 'obstructive resection' I believe, employs the admirable principles of the procedure of exteriorization and at the same time obviates undesirable features and a high rate of mortality. Although it has not been noted, so far as I know the Mikulicz procedure carries a higher operative mortality than any other type of resection. This obstructive type of resection I have employed as a routine in the last year as the operation of choice for all lesions in mobile segments of the large bowel. From January 10, 1929 to November 22, 1930, I performed 31 obstructive resections of the colon with a single fatality. The man who died was aged 64 years, he was of short and heavy build so that the operation was technically difficult. He died 36 hours after the operation from a pulmonary embolus.

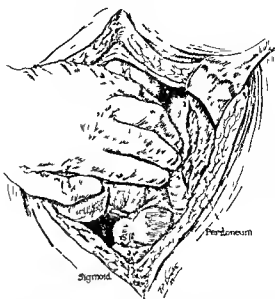


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<sup>1</sup>Submitted for publication January 24, 1930.

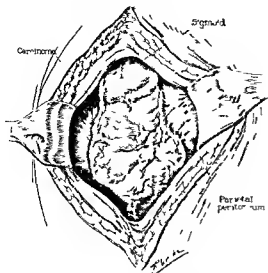


FIG. 1. Abdominal incision exposing carcinoma of the sigmoid.

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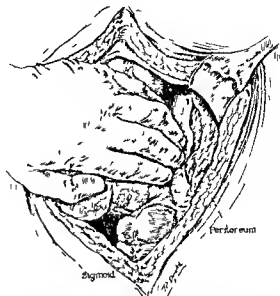


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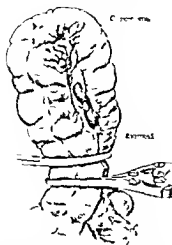


Fig. 3 Mobilization completed. The mesenteric blood vessels are ligated and a wide expanse of mesentery is sacrificed. The growth is caught between clamps to be removed with cautery.

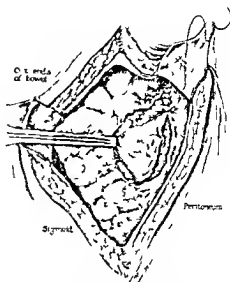


Fig. 4 The clamp is *in situ*. The growth has been removed and peritonization of the lateral raw surface is begun.

tive procedure and in whom, under local or light general anaesthesia, the growth may be drawn rapidly into the wound without manipulation or attempts at mobilization. Infection around the growth as Sistrunk stated, or considerable obstruction especially if it be subacute or acute is a definite contra indication to operation because of the necessary manipulation which spreads this infection to the peritoneal cavity, with unhappy results.

The pre operative measures, which have been mentioned, consist of the following: (1) rehabilitation of the general condition; (2) attempts at reduction of local infection and obstruction by cleansing measures applied to the bowel itself; (3) the use of intraperitoneal vaccine; and (4) the use of spinal anaesthesia. Fortunately the introduction of these methods has enabled me to overcome many of the difficulties which formerly attended operations on markedly infected or obstructive growths.

In acute intestinal obstruction even the most enthusiastic partisan would agree, I believe that there is little practicability in exteriorizing a growth without previously having provided for decompression above it and this procedure of decompression and exteriorization combined bears too high a mortality, as judged from statistical study. Paradoxically, the obstructive type of resection, which is under consideration cannot be done safely in the presence of obstruction of any type. As has been noted however my experience is that chronic intestinal obstruction confined to

the large bowel is borne readily over a long period of time and, what is more important, it may be reduced to a minimum in practically every case by the judicious use of cleansing measures applied over a considerable period of time on the average one week. Subacute obstruction and many times, almost complete obstruction of the large bowel due to a malignant condition can be removed by patience and persistence in the use of enemas and, occasionally, of purgatives. Of course, one does not advocate anything but immediate operation in acute intestinal obstruction, regardless of its cause, but acute intestinal obstruction of the colon due to carcinoma is found in only 5 per cent of all cases of intestinal obstruction, and is not included in the type of case considered here.

#### TECHNIQUE

The technique of obstructive resection is in reality, similar to two stages of the Mikulicz operation employed in one step with the additional removal of a wide piece of mesentery, and gland bearing tissue in proximity to the growth. The procedure is applicable as has been said only to mobile or mobilizable segments of the bowel. The steps of the operation are as follows: (1) incision over the growth and abdominal exploration; (2) mobilization of the growth; (3) ligation of the blood supply and dissection of lymph nodes; (4) resection of the growth between clamps, with the cautery; (5) peritonization and closure of the

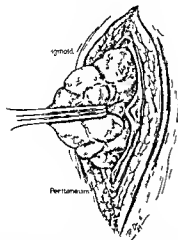


Fig. 5 The peritoneum is brought under the loop and is sutured snugly around on all sides. This step holds serous surface to serous surface, permits early healing and does away with the necessity of sutures in wall of the bowel.

rent in the mesentery, and (6) closure of the abdominal wound around the growth (Figs. 1 to 7).

It has been my custom to employ a two bladed clamp, which I use for aseptic anastomosis, else where, as the most satisfactory instrument for doing this obstructive resection. After mobilization of the growth, the clamp is applied to the two limbs of the bowel and at this stage of the operation one may always be certain of securing the blood supply to the loop. This is a most important step, and the blood supply may be determined under direct vision. The rent in the mesentery is closed without putting sutures into the bowel. The use of such sutures has never been a satisfactory practice and I have not been sorry to have omitted it. Peritonization of the raw surfaces lateral to the resected bowel is always easily accomplished. The clamp is now brought out of the wound at the point in the wound which leaves the structures most loose. The wound is closed snugly close to the clamp, and a tongue of peritoneum is pulled between the two limbs of the bowel, under the clamp. This brings up the peritoneum snugly around the bowel itself and does away with the necessity of sutures. Sometimes, when the loop has been short and has not come out of the abdomen readily, I have wrapped a piece of iodolorm gauze around the clamp in the peritoneal cavity and then have closed the peritoneum snugly around it so as to avoid contamination in case of leakage. When the operation has been completed, and the wound has been closed tightly around the clamp, the bowel is left totally shut off for at least 60 hours,



Fig. 6 After the clamp has been removed and the wound is healed the spur is cut out of the two gun barrels by the application of clamps which necrose through it slowly. This step is similar to that of the Mikulicz operation.

and sometimes for as long as 72 hours. I never have seen unhappy sequelæ from this one step and never have had to take a clamp off sooner than 60 hours after operation. Patients have not been nauseated and up to this time have not vomited, but I have not given them food by mouth. Their food has been supplied by hypodermoclysis and intravenous administration of glucose and sodium chloride solution. At this time the proximal blade of the clamp is opened, but the distal blade is left closed, and the clamp is not removed. This is advantageous because agglutination has taken place, the bowel has healed into the wound, and, if gas has caused enough tension, it will blow out the cut end of the proximal loop and will relieve itself spontaneously. I do not open the colon, but

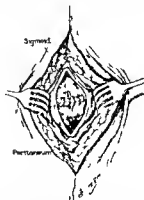


Fig. 7 Final stage of the operation showing closure of the colostomy opening. In more than half of the cases this step is unnecessary and spontaneous healing takes place.

prefer to let the agglutinated end be freed by distention from pressure within the colon. The clamp is allowed to stay on the distal loop until it drops off which usually occurs about the seventh day. The remainder of the operation is accomplished in a manner similar to that employed in the Mikulicz procedure—that is, the spur is cut out with an enterotome or with clamps, and the patient is then allowed either to return home or to wait for a period of at least a month before the subsequent step is undertaken. It has been my experience that in more than half of these cases if the spur is cut out properly the opening will close spontaneously without the necessity of the third stage of the operation.

It is obvious that there are many advantages to this type of resection over the former technique of exteriorization and resection of the large bowel. In my service I have come to look on it as the operation of choice in all non-obstructing mobilizable growths of the large bowel from the hepatic flexure of the colon to the middle of the sigmoid colon. From the standpoint of mortality and morbidity it leaves little to be desired. The period of hospitalization is short. After resection and removal of the spur between the two loops of bowel which in the average case have been done in 3 weeks it has been my custom to permit the patients to return home with the idea that the third stage of the operation or the necessary closure will be accomplished by nature rather than by surgical suture. I have been agreeably surprised to note that more than half of the patients have not had to undergo secondary closure. The number of stages of the procedure and the morbidity thus are reduced to a minimum. The record of mortality, approximately 3 per cent in this series, is so immeasurably better than that of the Mikulicz procedure that it does not require consideration. I am not optimistic that the mortality can be held at this figure but my mortality for resection of the colon which is

below 10 per cent is highly acceptable. A second obvious advantage is the radical type of operation which this procedure allows to be applied in removal of gland bearing tissues. Formerly procedures of exteriorization were simply for local removal of the malignant growth without dissection of lymph nodes and this in the light of present day knowledge of the enhancement of end results by block dissection of the adjacent groups of lymph nodes is unsurgical. It seems to me that it is just as desirable to apply radical methods with wide removal of adjacent tissues to malignant conditions of the large bowel as it is to apply them to malignant conditions of the lip, tongue, breast, stomach, or other organs. Any procedure which includes this among its accomplishments is highly advantageous.

The question immediately arises in connection with this obstructive type of resection as to whether or not it is feasible immediately to re-establish the lumen of the bowel with an aseptic type of operation. This no doubt would be the ideal procedure yet it unquestionably would be followed by an increase in mortality, an increase probably as high as 5 per cent. One is always tempted in doing a resection of the bowel when the bowel is mobilized satisfactorily, to make an anastomosis with perhaps an enterostomy for decompression proximal to it. However I have had sufficient unhappy experience with this type of maneuver in the past to be fearful of it although I recognize its great desirability. It is to be hoped that in the future with adequate co-operative management and proper selection of cases aseptic anastomosis in one stage with or without proximal decompression will become the operation of choice in a high percentage of cases of malignancy of the colon. At present I feel distinctly that the graded procedure will prove to give just as high a percentage of satisfactory end results and at the same time a considerably lower rate of mortality.

FROM THE SURGICAL CLINIC ST JOSEPH'S HOSPITAL

## THE TECHNIQUE OF VENTROFIXATION OF THE UTERUS

IRVIN ABELL M.A. M.D. F.A.C.S. LOUISVILLE KENTUCKY

**V**ENTROFIXATION of the uterus is indicated in the presence of complete protracted prolapse with eversion of vagina in women beyond the menopause.

The preparation of the patient for operation is that usually employed for abdominal operations: cleansing and shaving of the abdomen on the day before operation and the application of 2 per cent tincture of iodine to the field of operation before patient is taken to the operating room and again when on the operating table.

The anæsthetic may be local, general, or spinal with preference given to preliminary morphine and atropine followed by nitrous gas oxygen in elderly patients. The relaxation of the vaginal outlet is first corrected by colpoperineorrhaphy. The patient is then placed in the Trendelenburg position and a 4 inch midline suprapubic incision is made. The fundus of the uterus is grasped with volsellum forceps and drawn well up into the incision. The cut edge of the anterior parietal peritoneum is then sewed to the peritoneal covering of the uterus with a running suture of No. 2 chromic catgut which begins in the lower angle of the incision in the anterior parietal peritoneum and unites its cut edges to the circumference of the uterus at a point between the fundus and the junction of body with the cervix, after which the remainder of the incision in the peritoneum is closed with a continuous suture of similar kind. The fundus of the uterus having been thus made extraperitoneal the under surface of the fascia abdominis is prepared for anchorage of the fundus uteri by the separating of the underlying recti muscles from it for a distance of 1 inch from the cut edge on either side at the lower third of the incision. Sutures of No. 2 chromic catgut, one on either side, are then passed through the fascia from its upper surface. These sutures enter at points 1 inch from the midline, grasp the uterine muscle at or slightly below the cornua (depending on the size of the uterus), and pass back through the fascia from below (Fig. 1).

When these sutures are tied the recti muscles are displaced to either side with the fundus uteri interposed between them, its superior surface coming in contact with a sufficiently large area of fascia to afford a firm anchorage. Two stay su-

tures (equal in length) are then inserted through skin, fat, fascia, and fundus of the uterus, one on its anterior and one on its posterior aspect and if desired one or two of similar material are inserted in the upper half of incision (Figs. 2 and 3).

The fascia abdominis is closed with a running suture of chromic catgut, the needle dipping into the uterine muscle at the point of its contact with fascia (Fig. 4).

The skin is closed with dermal suture after which the stay sutures are gently tied (Fig. 5).

The postoperative care is that of the ordinary closed abdominal section: rest in bed for 2 weeks with avoidance of severe physical exertion for a period of 6 weeks thereafter (Fig. 6).

## ADVANTAGES OF THE OPERATION

1. The uterus becomes an integral part of the abdominal wall and is fixed to its unyielding fascia.
2. The suturing and anchorage are extra-peritoneal.
3. It affords adequate and permanent support for the relaxed pelvic structures.

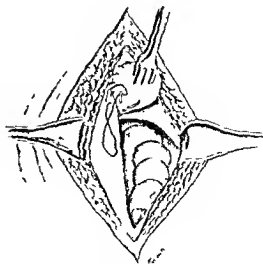


Fig. 1. Suturing of cut edges of peritoneum to circumference of uterus.



Fig. 2 Separation of fascia from underlying rectus muscle

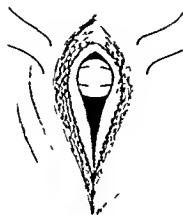


Fig. 4 Stay sutures passing through entire abdominal wall down to and including uterine muscle



Fig. 5 Closure of fascia

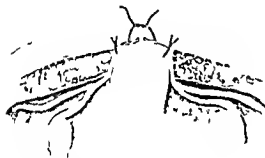


Fig. 3 Sutures placed lateral to midline anchoring fascia to uterine cornua

4 The normal vaginal depth and relations are retained

5 The relaxation of the pelvic structures in complete procidentia is of such degree that no undue tension with consequent discomfort results

6 The ease and rapidity of execution permit its employment in the aged granted no absolute contra indications to a surgical procedure exist

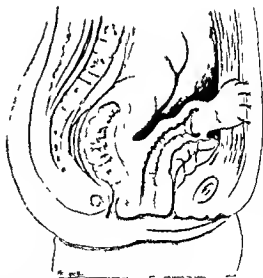


Fig. 6 Position occupied by uterus completed operation

RECONSTRUCTION OF THE EXTERNAL EAR<sup>1</sup>

GEORGE WARREN PIERCE M D SAN FRANCISCO

THE reconstruction of an external ear is a difficult task. The normal auricle is composed of two layers of thin skin with little subcutaneous connective tissue, supported and given form by a thin intricately shaped cartilage. It is impossible to obtain skin of this type from other available parts of the body, and rib cartilage, the ear cartilage substitute, is not suitable for fashioning into a replica of the original support. Moreover, if so fashioned, it will not maintain its form and contour, but tends to fold up. This tendency of reconstructed auricles to shrink has been one of the apparently insurmountable difficulties of the task of reconstruction.

My method of reconstruction furnishes an ear which does not shrink and which maintains the normal angle to the head. It is more important to have the two ears of the same size than of exactly the same contour. The characteristics of the minor contours of the pinna vary so widely in people that less effort need be expended on their reproduction than on the size and proper angle of the ear. All stages of the reconstruction are done under anesthesia produced by the administration of a 1 per cent solution of novocain.

CASE 1. This patient referred by Dr Russell Ryan is an illustration of the comparatively simple problem of restoring the size and general appearance of the ear after loss

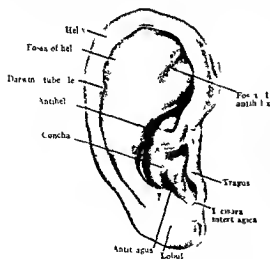


Fig. 1. Pinna. Reproduced from Deavers' *Surgical Anatomy*. By permission of P. Blakiston's Son & Company, Philadelphia.

of the helix by burn from a gasoline explosion. Since the helix had been destroyed, there remained the antihelix with a thin scarred edge and a proportionate reduction in size of the pinna. The first operation was done October 19, 1925. The helix was reconstructed from a small tubed pedicle flap from the neck (Fig. 2a). This flap was transplanted upward in three stages; the pedicle was opened along the suture line and was then sutured to the split edge of the antihelix. The skin of the lower part of the neck is thinner than that of the upper part of the neck or of the chest and matches closely the color and texture of the normal helix. This is of great importance as material taken from other parts of the body so rarely has the requisite coloring and appearance for an auricle. Four operations were required for this case and were performed on October 19, December 1, and December 10, 1925. The progress of the case was uneventful, healing occurring by first intention. The final result is shown in Figure 2b reproduced from a photograph taken January 2, 1926.

CASE 2. This case illustrates practically the reconstruction of the entire pinna. The patient lost the external ear in an automobile accident and was referred to me by Dr C. Coleman Berwick of San Francisco. Only the lobule, the tragus and the external auditory canal remained (Fig. 3a). The tragus and lobule are the simplest parts of the ear to reconstruct. The problem then was to construct the remainder of the pinna with its natural contour, coloring and size and with the proper angle between it and the head. It was necessary also that the completed member should show no tendency to shrink. This tendency has been one of the major difficulties of ear restoration.

The first operation was done August 14, 1926. At that operation the right eighth and ninth rib cartilages were removed. A strip of cartilage 4 centimeters by 6 centimeters was prepared from the eighth rib cartilage and the perichondrium was removed. This cartilage was placed in a tunnel between the skin of the scalp and the temporo-mandibular fascia through a small incision 6 centimeters above and behind the external auditory meatus. This strip of cartilage was then in position to thrust against the tissue which is closely adherent just above the meatus. The ninth rib cartilage and the remainder of the eighth were buried in the fat of the abdominal wall.



Fig. 2. a. Left. Loss of helix from burn. Tubed pedicle flap has been transferred upward at one end. b. Completed pinna. Tubed pedicle flap sutured to split remains of antihelix.

<sup>1</sup>Read before the meeting of the California State Medical Society at Sacramento, California, May 3, 1925.

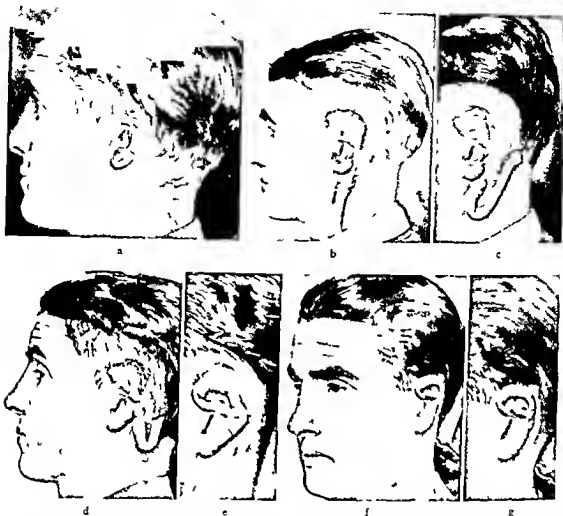


Fig. 3 a Loss of entire pinna except lobule and tragus b Cartilage has been implanted under the scalp epithelial inlay done behind flap and one end of the tubed pedicle flap transplanted upward c Stent has been removed from epithelial inlay and tubed pedicle flap again transplanted d Tubed pedicle flap transplanted into lobule e Opened

tubed pedicle flap sutured into split edge of scalp flap f New helix has been trimmed and finer contours of pinna reproduced with implantations of rib cartilage g Pinna near completion Finer contours may be reproduced till further

On October 1 1926 a tubed pedicle flap of the Gilhes type was made on the lower part of the neck on the same side as the proposed pinna. The pedicle flap was 1 centimeter in diameter and 16 centimeters in length. It is surprising how small in diameter these pedicle flaps can be made and how well they maintain their nutrition through successive transplantations. The skin selected for the pedicle lies just above the clavicle and parallel to it.

On January 6 1927 a semilunar incision was made in the shape of the proposed pinna with a radius of about 5 centimeters from the upper border of the external auditory meatus. The incision was carried through the temporo-mandibular fascia so that the cartilage had a protective covering on its inner surface. A model of the defect behind the flap was then made with warm dental modelling com-

pound and a Thiersch graft of one piece taken from the thigh was wrapped about the model raw surface out. The model and graft were then buried under the flap and the wound sutured. This is the typical epithelial inlay of Esser. The tubed pedicle from the neck was transferred upward at the same operation by cutting free the lower end and transplanting it upward to the upper part of the neck just below the lobule. This stage is shown in Figure 3b. Ten days later the suture line was opened above the epithelial inlay and the wax model was removed. As is usual with this method of skin grafting there was a complete take of the graft so that no raw areas remained and the flap with its cartilage support stood out at a proper angle from the head as shown in Figure 3c. On March 17 1927 the lower end of the tubed pedicle was transplanted



Fig. 4 a Loss of upper half of pinna by accident b First stage as in Figure 3b Scalp flap smaller c Stent removed Lower edge of flap sutured to upper edge of remainder of pinna d Pedicle flap transplanted upward e Pedicle flap transplanted to upper extremity of helix f Transplantation of pedicle to scalp flap complete g Posterior view of new pinna showing angulation to head h Pinna as at present Readjustments and reconstruction of finer details of antihelix to follow

On May 20 1927 the pedicle was freed at its distal end and opened its full length along the scar of the suture line and sutured into the flap representing the antihelix after the flap had been split along the edge to receive the raw surface of the pedicle (Fig. 3e). The result was only a crude representation of a pinna but it formed a substantial foundation for the rebuilding of the pinna contours. Several small readjusting operations were done at intervals. Most notable of these were the narrowing of the pedicle now become helix and the implantation of a small strip of cartilage taken from the cache in the abdominal wall and placed to represent the superior border of the concha (Figs. 3f and g). Since completion this ear has shown no evidence of shrinkage. It has taken on a coloring almost indistinguishable from the opposite ear with

upward this time joining with the stump of the lobule and blending with it as shown in Figure 3d.





Fig. 5. a Congenital absence of pinna. Lobule present but folded forward. Small amount of cartilage present beneath scalp. b Lobule unfolded and cartilage redistributed.

c Reconstructed pinna at present. Implanted rib cartilage has reproduced tragus. Further details of antihelix will be worked out with strips of rib cartilage.

the helix much pinker than the antihelix. The few hairs which came as a legacy with the scalp were removed by the use of the electric needle. In the author's opinion this is the only method by which hairs should be removed from these flaps. A depilatory dose of roentgen ray is so close to a destructive dose that permanent damage may result or at least scarring and telangiectases.

**CASE 3.** This patient suffered the loss of the upper half of the pinna as the result of an accident. The healed stump is shown in Figure 4a. The same principle of reconstruction was used as had been successful in Case 2. The first operation was done on July 27, 1927, when the rib cartilage was buried beneath the scalp and the tubed pedicle constructed on the lower neck. On August 22, 1927, the flap was cut and the epithelial inlay was carried out while at the same time the lower end of the tubed pedicle was transplanted upward behind the lobule as shown in Figure 4b. One week later the wax model was removed as illustrated in Figure 4c. On September 3, 1927, the lower edge of the flap was sutured to the upper border of the remains of the pinna after both had been split. Transplantations of the tubed pedicle are shown in Figures 4d and e. Figure 4f indicates the completed suturing of the pedicle to the flap while Figure 4g, showing a posterior view, illustrates the manner in which the cartilage bearing flap stands out from the head. The reconstruction is not complete, as the patient is to return for further remodelling of the pinnal contours.

Congenital absence of the external ear is not unusual, occurring in about 1 in 20,000. At present I have under my care 5 cases of this type. This anomaly is generally accompanied by other evidences of maldevelopment on the affected side such as absence of the mastoid cells, the external auditory canal, the membrana tympani, the middle ear, the cochlea, or the semicircular canals. Also the seventh cranial nerve may run an anomalous course or may be only partially developed thus giving the symptoms of a facial paresis, as in

one of my cases. Underdevelopment of the entire side of the face so that it has a dish-like appearance is common.

Some postmortem findings have been reported as follows:

J. C. Beck, in the *Laryngoscope* of November 1923, reported a case with a rudimentary ear. Postmortem examination showed that the internal auditory meatus of the defective side (right) was very small compared with that of the other side. Nerve was present in the canal but there was a question whether it was the facial or the auditory part of the nerve. No middle ear, no cochlea, and no mastoid cells were found but there were two vestiges of semicircular canals. The left ear was normal.

R. C. Lynch, in the *Laryngoscope* 1913, No. 23, reported a case of congenital absence of both ears. A skin incision was made where the mastoid should have been. When the periosteum was peeled away, the temporomaxillary joint was found instead of a canal behind the smooth outer table present in the squamous portions of the temporal bone. The facial nerve came out of the skull just behind the neck of the maxillary articulation without any evidence of a styloid process. When the outer table was clipped off the diploë was revealed.

I. P. Anzinger, in the *Ohio State Medical Journal* of December 1913, reported a case of congenital absence of the right ear with cleft of the upper left eyelid. The right ear was missing but there were three rudimentary skin tags just in front of the right ear zone. Postmortem section over the right temporal area showed the skull bone to be perfectly smooth with no evidence of auditory canal.

In the face of these facts it is in most cases not advisable to open the external auditory canal. Only in those cases showing radiographic evidence of well developed mastoid cells and an auditory canal and giving unmistakable evidence of hearing on the malformed side should the opening be attempted. H. B. Graham has successfully ac-

complished the opening of such a canal and writes me as follows

The patient a boy aged 3 years presented a lack of both canals with an absence, on one side of nearly the entire concha and on the other side with the cartilage of the concha buried beneath the skin of the head. X-ray examination showed a well formed middle ear and the maxillary joint well anterior to the mastoid process. The hearing was so poor that the child's speech was nearly unintelligible and he was very hard to manage. At operation an attempt was made to open the canal to a point as close to the promontory wall as possible the mastoid cells and anterior wall of the mastoid process being removed. A skin graft was then introduced and shaped around dental modelling compound in the attempt to secure the formation of an open canal. This was only partially accomplished but the hearing was improved to such an extent that the child soon learned to talk and became much more reasonable in his relations to other children and to the family. Further cosmetic surgery was left for a later date.

CASE 4. This case referred to me by Dr. Walter Harder (Fig. 5a, b and c) is an example of construction of the external ear in a patient in whom it was congenitally absent.

In this case the external ear consisted of a completely formed lobule which was folded forward. In addition three small fragments of cartilage just above the lobule presented the only evidence of pinna. The X-ray picture revealed fairly well developed mastoid cells and an auditory canal. The patient seems definitely to hear on this side probably by bone conduction.

At the first operation done August 17, 1927 the infolded lobule was unfolded and the cartilages rearranged (Fig. 5b). The procedures illustrated in Case 2 were then followed with the result shown in Figure 5c. The procedure is of course incomplete. There is a considerable store of cartilage still in the abdominal wall and this will be implanted in strips to give the proper contour to the antihelix and concha.

#### CONCLUSIONS

This method of reconstruction of the pinna possesses the following advantages

- 1 All stages of the reconstruction can readily be done under local anesthesia
- 2 The method requires for hospitalization only one period of a few days when the rib cartilage is removed and an occasional day when each succeeding stage is accomplished. In the intervals the patient is not disabled
- 3 The new auricle does not shrink or fold up
- 4 The coloring of the new helix and antihelix compares favorably with that of the normal ear
- 5 In point of size and angular contact with the head it may be constructed to match the opposite ear
- 6 With patience most of the finer details of contour may be attained

HEMOLYTIC ICTERUS AND THE TECHNIQUE OF SPLENECTOMY<sup>1</sup>

H. H. H. MD FACS WOODLAND CALIFORNIA

From the Department of Surgery Woodland Clinic

**C**HRONIC hemolytic icterus is a disease characterized by splenomegaly, jaundice, the absence of bile pigments in the urine, the presence of coloring matter in the stools and a diminished resistance of the red blood cells to hemolysis.

In 1890 Wilson first described cases of congenital jaundice associated with splenomegaly and in 1898, Hayem described similar cases that were acquired. The congenital form of hemolytic icterus later was associated with the names of Chauffard and Minkowski. The acquired type became known as the Hayem Vidal form of the disease.

The Chauffard Minkowski form of the disease may be either congenital or familial. In the former instance jaundice appears very early in life while in the latter it appears later but usually during childhood. In both of these varieties, there is usually a history of other cases in the family. The Hayem Vidal form may appear at any time, but usually during early adult life.

The symptoms of the congenital and the acquired types of hemolytic icterus are very similar. There is usually a marked difference in the intensity of the symptoms in the two types of the disease. In the congenital or familial the patients as Chauffard said are "more jaundiced than sick." They may lead normal lives and remain completely free from subjective symp-

toms. These patients may live to an advanced age with no serious inconvenience from their disease.

On the contrary, the acquired form is much more severe. The disease may begin insidiously with the appearance of a mild icterus, or by a violent sudden onset of pain, fever, and the development of a marked jaundice in an attack which simulates that of an obstruction of the common bile duct with a gall stone. The attack subsides but the jaundice persists though it becomes less intense. These attacks occur at varying periods of time. Anemia appears, increases and may become fatal unless treatment is given.

The etiology of the condition is obscure. It is generally believed to be based upon some toxic or infectious cause.

Our present conception of the origin of jaundice in hemolytic icterus is due to Ashoff's ideas of the reticulo endothelial system to Whipple's and Mann's apparently successful attempt to produce experimental jaundice in animals when the liver had been entirely excluded from the circulation and to Pearce's work on the spleen and its relation to hemolysis. The more accurate methods of detecting the slighter changes in the blood introduced by Van den Bergh have amplified the results obtained in earlier research and have led directly to the formulation of the new hypothesis of the mechanism of jaundice. The differential diagnosis between hemolytic and non hemolytic jaundice can often be established by this method.

McNee has classified jaundice as obstructive, hemolytic and toxic or infectious. This classification correlates very well with the clinical facts and experimental data now available. Hemolytic icterus is a disease of the entire hematopoietic system. The source of jaundice is chiefly from the liver, spleen and bone marrow.

The jaundice of hemolytic icterus is caused by an accumulation in the liver of the products of cell disintegration to such an extent that the liver is unable to take care of them properly and a certain amount of altered pigment is absorbed into the blood stream. This jaundice is unusual. It is mild, deepens during a crisis and never becomes dark brown as in a long standing obstructive jaundice. The urine does not contain bilirubin and the stools do not contain stercobilin, their normal coloring agent. No itching is present nor is there a decrease in the coagulability of the blood.

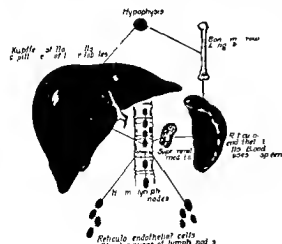


FIG. 1. Hematopoietic system

<sup>1</sup>Read before the California State Medical Association at Woodland, May 8, 1929.

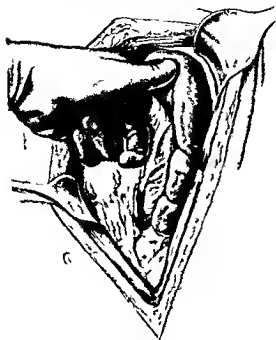


Fig. 2 Division of lienogastric ligament

The spleen is a hæmolymp node and a part of the hæmatopoietic system (Fig. 1). It may be considered as a coarse filter for cellular elements of the blood that have outlived their usefulness especially for the breaking down and removal of degenerated red blood cells and as a limited source of white blood cells.

The pathogenesis of the disease has been explained in two ways. One group of investigators believes that it is essentially an increased fragility of the red cells or in other words that the cause of the disease is to be found in a perversion of the function of the bone marrow which produces cells that are more easily fragmented than normal cells. According to this theory the splenomegaly is merely the reaction of the spleen to the presence in the blood of an increased number of cells that are ready for destruction. The other school believes that the cause of the disease lies in the spleen. This organ for some reason is excited to overactivity and destroys more cells than under normal conditions. Neither of these theories is adequate to explain all of the findings in the disease.

The increase of fragility of the red cells is a demonstrated fact in so far as our methods are capable of demonstrating it. The resistance of the



Fig. 3 Freeing of adhesions over spleen

red blood cells has returned to normal in a large number of cases when successful splenectomy has been done. Frequently, even though the patient is clinically cured, this resistance of the red blood cells remains unchanged.

In the absence of the spleen, erythrocyte disintegration takes place in various remote areas of the body, probably the bone marrow and possibly the hæmolymp nodes. Under these circumstances the products of red cell destruction reach the liver by a longer route and in a less concentrated form. The liver is better able to take care of the material, and jaundice results only when red cell destruction has reached a higher degree than is required when the spleen is present.

It has also been suggested that the increased fragility of the red cells is due to the action of some toxins either produced in the spleen or in some way activated by it. This theory has little evidence to support it.

There is no characteristic pathological picture in hæmolytic icterus. There is a deep congestion of the pulp and active phagocytosis of the red cells both by the macrophages and by the polynuclears. The spleen is always enlarged some times enormously so and contains an increased



FIG. 4. Elevation of spleen and placing of gauze pack.



FIG. 5. Separation of pedicle into two parts and division.

amount of iron containing pigment. There is usually a slight degree of fibrosis and thickening of the capsule and areas of perisplenitis may be found.

The liver may be occasionally enlarged and show a biliary cirrhosis. The kidneys and bone marrow are also deeply pigmented. The bone marrow is of the erythroblastic type and offers no histological evidence of any abnormality in the mode of erythrocyte production.

Cholelithiasis is present in about 60 per cent of cases. Typical gall bladder disease may complicate the symptoms.

The blood picture varies with the degree of intensity. The red cells show well marked anisocytosis with a predominance of microcytes rather than macrocytes. These microcytes are often irregular in shape and have been described as fragmental forms of cells. Polychromatophilia is marked, but granular degeneration is not so frequent. There is a marked increase in reticulated reds stained by vital stains. Normoblasts are found occasionally. Myelocytes may be present. Megoblasts and myeloblasts are rare. The hemoglobin is usually low and the color index below 1.

The blood serum generally contains urobilin. Bilirubin is present as a rule only during a crisis. The urine contains urobilin often in very large quantities. The amount of urobilin in the stools and duodenal contents is increased to many times the normal amount.

The mortality when splenectomy is performed is 16 per cent in 63 cases as reported by Elliott in 1917. The statistics of the Mayo clinic show a mortality of 7 per cent in 37 cases. Recovery is as a rule rapid and complete. No operative procedure should be contemplated when active hemolysis is taking place. Preparation by transfusion is often a necessity.

The success of splenectomy depends in a large measure on the selection of the time of operation and careful pre operative preparation.

Folb<sup>10</sup> are the reports of 2 cases illustrating the congenital and acquired types of this disease with complete symptomatic cure following splenectomy.

CASE 1. F. M. S. a male aged 6 weeks was first seen on March 9, 1926. His family history was essentially negative. The past history showed normal delivery, but the child had not gained well. He had been jaundiced and constipated for 1 week. Physical examination showed marked jaundice.



Fig. 6 Peritonizing raw surfaces of diaphragm and splenic pedicle

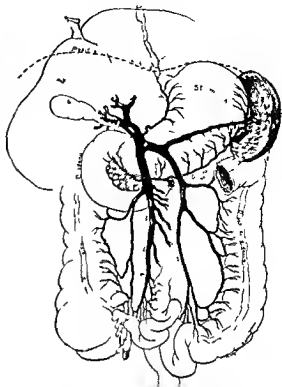


Fig. 7 Relationship of stomach, tail of pancreas, and splenic flexure of colon to the spleen surface and pedicle and dangers encountered with injury to these organs in surgical removal

and anemia. The spleen was much enlarged. Laboratory examination showed hæmoglobin 32 per cent, many normoblasts and megaloblasts, and moderate polychromatophilia. The red cells exhibited fragility within normal limits.

Transfusion was given March 13, 1926, with marked benefit. Jaundice lessened, hæmoglobin increased. Transfusions (12 in all) were given at short intervals with temporary benefit. The first 6 transfusions were given through the anterior fontanelle, the last 6 intraperitoneally. The child's attacks of increased jaundice and anemia were frequent but only moderately severe. However, no permanent improvement could be obtained. The serum bilirubin was increased and the urine showed a considerable amount of bile. The fragility of the red blood cells was only slightly increased at any time.

Splenectomy was done on April 25, 1927. The weight of the spleen was 170 grams. The gall bladder was small, atrophic, thick-walled, and inflammatory; there were no stones. No hepatitis was discovered. The child's progress following splenectomy was entirely satisfactory. His growth and development were normal for his age. On April 8, 1928, the hæmoglobin was 75 per cent.

CASE 2. M. R., a male aged 15 years, was first seen January 1, 1925. His family history was essentially negative. He had had tonsillitis frequently; adenoids had been removed. The boy had been jaundiced at birth. This condition had cleared promptly and the patient had been perfectly well to the age of 2½ years when he had been

jaundiced for 3 weeks, then he had been well to the age of 4 years when he had had an attack with high fever and abdominal pain. He had never been well since this attack. Following this he had had many attacks characterized by diarrhoea, severe headache, sore throat, and deep jaundice. There was no severe upper abdominal pain and little gas or sour stomach. He had periods of severe anemia. Physical examination showed a very pale, anæmic, and jaundiced boy. His tonsils were markedly diseased. The spleen was enormously enlarged and tender. Laboratory examination gave the following results: hæmoglobin 43 per cent, polychromatosis and anisocytosis, marked increase in fragility of the red cells, and urinalysis essentially negative.

Transfusion was given on January 2, 1925. The hæmoglobin on January 8 was 22 per cent.

Splenectomy was performed on January 14. The weight of the spleen was 2,000 grams. The gall bladder was thick-walled and there were no stones. The liver was normal. Transfusion was immediately given. The patient showed a rapid gain in strength and growth. On December 31, 1927, the hæmoglobin was 80 per cent. He has attained normal growth and size and shows marked thickening of the cranium.

Splenectomy was performed in the first instance on a child 15 months old and, at the present time, the patient is apparently normal. As far as my

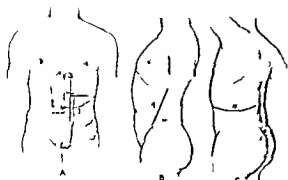


Fig. 8. A. A. Posterior or dorsal lumbar incision. B. S-shaped midline incision. C. Paramedian laparotomy with horizontal incision. D. Thoraco-abdominal incision. E. A. Posterior or dorsal lumbar incision.

information goes this is the youngest patient with hemolytic icterus reported in the American literature. In England Taylor reported 3 cases of very young children 9, 11 and 13 months respectively on whom splenectomy was done.

My second case is classified as an acquired type because of the intensity of the symptoms. Repeated attacks of profound anemia followed one another over a number of years. Marked thickening of the skull occurred before splenectomy and the increase was about twice to three times normal thickness after splenectomy which illustrated the marked activity and involvement of the bone marrow. No bones except the skull were involved in this process. Wilson notes a similar condition in his patient. M. Ganssler states that 11 of his 27 patients had steoplastic skulls.

The diagnosis of hemolytic icterus is difficult at times. To reach a definite conclusion observation must extend over a considerable length of time. As Kennedy has shown there is among children a considerable group of enlarged spleens which can not be classified.

The choice of operative incisions varies with the size of the spleen and the perisplenitis to be encountered. Figure 8 illustrates various possible approaches. The straight left rectus incision as advocated by Balfour is the most advantageous in splenic anemia. The stages of splenectomy are illustrated in Figures 1, 2, 3 and 4. The dangers of possible injury to the stomach, pancreas and large bowel due to their close proximity to the spleen are best illustrated in Figure 7.

#### CONCLUSIONS

1. Hemolytic icterus either acquired or congenital, requires splenectomy for permanent clinical cure which is obtained by this measure.

The mortality is comparatively low, when careful preparation has been made.

#### LITERATURE

1. STARR, D. W. The technique of splenectomy. *Surg., Gynec. & Obst.* 1916, XLVI, 1.
2. HEM. Indications for splenectomy in certain chronic diseases. *J. Am. M. Ass.* 1916, LVII, 300.
3. HEM. *Surg., Gynec. & Obst.* & *Internat. Abstr. Surg.* 1916, XLVI, 1, 15.
4. BAKER. Some observations on congenital and acquired hemolytic icterus. *Med. Rec.* 1916, XC, 1.
5. CHATELAIN, A. *Pathologie de l'ictère*. *Compendium de l'adulte*. *Semaine méd.* 1927, XXVII, 23.
6. CONNOR. Hemolytic jaundice in children. *Arch. de méd. enf.* 1927, XXX, 99.
7. HEM. Hemolytic icterus and other anemias with special reference to the fragility of the red corpuscles. *Illinois M. J.* 1916, LXX, 240.
8. DE TAYLOR, C. Some problems of jaundice and their significance in surgery. *Ann. Surg.* 1914, LXXX, 643.
9. LEBERT and KAVEL. Splenectomy for hemolytic icterus. *Surg., Gynec. & Obst.* 1913, XXI, 21.
10. LEBERT. Splenectomy for hemolytic icterus. *Illinois M. J.* 1912, LXVIII, 18.
11. CHATELAIN, A. Hemolytic jaundice. *Deutsche Arch. f. Klin. Med.* 1922, p. 220.
12. CUFFIN. Hemolytic jaundice: a review of seventeen cases. *Surg., Gynec. & Obst.* 1917, XXV, 132.
13. CUFFIN, SANFORD and SZLAPKA. The estimation of urobilin and urobilinogen in the duodenal contents. *Am. J. M. Sc.* 1918, CLV, 562.
14. CUFFIN. Present status of splenectomy as a therapeutic measure. *J. Minn. M. Ass.* 1917, LV, 1232.
15. CUFFIN, H. Z. Splenectomy. *Surg., Gynec. & Obst.* 1927, XLV, 57, 58.
16. CRILE, C. H. and CONNER, H. M. Diseases of the liver. *Arch. Int. Med.* 1926, XXXVI, 167-183.
17. HUGGARD. Splenectomy in the anemias. *J. Am. M. Ass.* 1911, LXX, 0.
18. HILL. The resistance of the red blood cells to hypotonic salt solutions in the various anemias. *Arch. Int. Med.* 1914, XVI, 809.
19. KENNEDY, K. L. J. Diseases of children benefited by splenectomy. *J. Am. M. Ass.* 1923, XCI, 8, 4, 8, 9.
20. LARROCHE. Chronic hemolytic icterus. *Boston M. & S. J.* 1911, 1, 513.
21. MCCARTY, W. C. Chronic splenomegaly. *Arch. Int. Med.* 1913, XLII, 36, 38.
22. MANN, FRANK. The site of formation and source of bilirubin. *Arch. Path. & Lab. Med.* 1926, III, 510.
23. MAY, J. Hemolytic icterus. *J. Minnesota M. Ass.* 1921, IV, 138.
24. MAYO. The relation of the splenic syndromes to the pathology of the blood. *Illinois M. J.* 1921, XL, 1, 4.
25. MAY, W. J. Dyscrasia of the blood. *New Orleans M. & S. J.* 1921, LXXIX, 99, 304.
26. MEKLEN, K. O. Hemolytic jaundice. *Deutsche Klin. Wochenschr.* 1900, CLXXI, 310.
27. MOHRITZ. The function of the spleen with particular reference to hemolysis and the hemolytic anemias. *Boston M. & S. J.* 1914, CLXX, 289.
28. PHARCE, KRUMHOLTZ and FRANK. The Spleen and Anemia. Philadelphia and London: J. B. Lippincott Company, 1918.
29. POOL, L. H. and STILLMAN, R. C. Surgery of the Spleen. New York: D. Appleton and Company, 1923, pp. 313, 322.
30. WILSON, D. C. *Clifton M. Bull.* 1924, September.

## RUPTURE OF TENDONS OF THE HAND

WITH A STUDY OF THE EXTENSOR TENDON INSERTIONS IN THE FINGERS

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**S**trong are the tendons that doubt has been expressed by some that rupture really occurs unless some pathological change be present in the tissue. In most cases (Honigsmann) the joints subluxate or luxate or the bones fracture or the muscles tear through at the musculo-tendinous junction or the tendinous insertion gives way (Bange) before the tendon itself tears through. Adams adds an interesting case to those reported in the literature illustrating the remarkable tensile strength of the tendons. A seaman caught the tips of the right middle and ring fingers in a door jamb and apparently jerked his hand away quickly, with a resultant crushing injury to the ring finger and amputation of the distal phalanx of the middle finger. The whole tendon and muscle belly of the flexor digitorum profundus (15 inches in all) pulled away with the amputated finger tip. Odermatt remarks that the condition may not be so rare as is supposed noting that Gruber found two instances of complete rupture and one incomplete tendon rupture among 1,200 hands (600 cadavers). In our experience subcutaneous rupture is not of frequent occurrence though it is not improbable that in many instances the condition does not cause sufficient functional disability to lead the patient to a surgeon.

Subcutaneous tendon ruptures may be divided into a number of different types and classified in many ways. The most frequent classification is the one used by Stapelmoor who divided the conditions into those following a direct blow on the tendon, those following an indirect trauma and lastly the spontaneous tendon ruptures which may be either post-traumatic or due to a disease of the tendons. Those due to direct trauma are by far the most unusual though extensor tendon rupture over the proximal interphalangeal joint is said by Hauck to be usually due to direct trauma.

From the anatomical location tendon ruptures of the hand may be classified as follows:

## A Rupture of the extensor tendons—

- 1 At the insertion into the distal phalanx
- At the insertion into the middle phalanx
- 3 Rupture or dislocation over the metacarpophalangeal joint
- 4 Rupture at the wrist

## B Rupture of the flexor tendons

- 1 In the fingers
- 2 At the wrist

## RUPTURE OF THE EXTENSOR TENDONS

*At the insertion into the distal phalanx.* Indirect injury may lead to rupture of both normal and pathological tendons, the normal tendons which most frequently rupture following indirect injury are the extensors of the third, fourth, and fifth fingers at their insertion into the terminal phalanx. Schlatter in a group of 34 cases of tendon rupture over the terminal phalanx found 22 on the right side and 9 on the left side, 12 affecting the middle finger, 9 the ring finger, and 10 the little finger. Males are more often affected than females. The injury appears to occur after apparently slight trauma. Thus in two cases reported by Durbán a mother and son were injured in exactly the same fashion, during the removal of stockings. While stripping the stocking from the leg the tip of the actively extended middle finger caught in the elastic seam at the top thus leading to a forceful passive flexion of the terminal phalanx, something seemed to crack and the finger tip was found flexed and could not be extended. In one case here illustrated the identical trauma, stripping off of stockings, led to rupture at the base of the distal phalanx of the right middle finger (Figure 1 shows result of operative repair). A patient recently seen caught his hand in a garage door which he was closing behind him (Fig. 2). The right middle finger was caught between the two leaves of the door in such a way that the finger was forcibly flexed at both interphalangeal joints while the metacarpophalangeal joint was still extended. This injury is not infrequently seen on the baseball field due to a blow on the tip of an extended finger and it is from this association that it receives its name of baseball finger. The injury consists usually of a capsular tear associated with a separation of the tendon from its insertion. Since the two structures, capsule and tendon, are here

TABLE I—SUBCUTANEOUS TENDON RUPTURE

- A Direct trauma—tendon caught between bone and traumatizing agent
- B Indirect trauma—forcefully contracting tendon subjected to forceful passive force in opposite direction
- C Spontaneous rupture—
  - 1 Post-traumatic—e.g. epiphyseal injury or degeneration of tendon due to injury severe or often repeated minor trauma
  - 2 Disease of tendon—e.g. tuberculosis, gonorrhea, syphilis, gout, etc.





Fig. 1 Result one and one half years after repair of ruptured extensor tendon over distal interphalangeal joint of the right middle finger. While removing the stockings the patient caught the tip of the actively extended finger

against the inelastic seam at the top of the stocking causing forceful passive flexion and subcutaneous rupture of the tendon

so intimately united that they cannot be dissected as separate and distinct structures. It is difficult to say which broke through first. In some cases (Glass Durban Schlatter) the tendon in pulling away from the bone takes a small shell of the distal phalanx with it, a condition which can be nicely demonstrated by lateral roentgenograms.

Swelling associated with considerable pain comes on quite rapidly after the injury. The typical flexion deformity which results (Figs. 12 and 13) is often diagnosed as a dislocation and this is reduced and splinted in extension. Often not until the splint is removed is the true condition recognized and proper treatment instituted. A certain number (especially those in which a cortical fracture is present) will heal if kept splinted for from 6 to 8 weeks in slight hyperextension. For this purpose numerous ingenious removable metal and celluloid splints have been devised (Sonntag Glass) and good results have been obtained from their use. Lewin's splint (Fig. 3) has been used by us and found very satisfactory. The regenerative powers of the extensor tendons (which are not enclosed in sheaths) are such that if given a chance and good approximation healing will occur. Occasionally however the tendon heals in a lengthened condition even with the best of treatment. In a patient recently treated by Dr. Kanavel the tendon had healed but was too long to permit complete extension. To obtain shortening it was necessary to make a step cut incision

through the tendon and overlap the ends to obtain a shortening of 1 centimeter.

Since healing is likely to occur with the tendon in a lengthened condition with subsequent dropped finger tip and since the joint space is always opened into by the trauma with the possibility of tags of tissue lying within the joint which may become ankylosed, operative repair of the injury is the method of treatment of choice. Exposure of the injured area is best done through an incision which does not lie directly over the line of proposed tendon and capsule suture which does not interfere with the nail bed and gives adequate space for suturing. This may be accomplished by an L shaped incision over the dorsum, the long limb of the L running along the posterolateral surface of the finger and extending from a point 1.5 centimeters proximal to the distal interphalangeal joint to a point 3.4 centimeter distal to the joint. The short arm of the L passes transversely across the finger proximal to the nail bed from the distal end of the longer incision. Usually little difficulty is experienced in approximating the tendons since separation is not great due to the attachment to the proximal interphalangeal joint. The joint cavity should be inspected for tags of tissue which may have found their way into it and if any are found they should be removed. The tendon and the joint capsule are then carefully repaired with fine silk sutures. During the suturing the terminal phalanx is held in slight hyperextension. After



Fig. 2

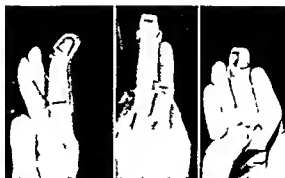


Fig. 3

Fig. 2 left Typical deformity resulting from rupture of the extensor tendon insertion into the distal phalanx. The actively extended finger was caught in a garage door in such a fashion that the interphalangeal joints were forcibly flexed.

Fig. 3 The Lewin splint for baseball finger i.e. rupture of extensor tendon over the distal phalanx. The splint may be used immediately after the injury or after operative repair. It holds the joint in hyperextension, an important point since the tendon is likely to heal in lengthened position.

skin closure, the finger is kept slightly hyperextended on a volar splint for 3 weeks at the end of which time movements are allowed and physical therapy instituted. The results are usually good if asepsis has been rigid and if healing occurs without infection.

*Rupture of dorsal aponeurosis over the proximal interphalangeal joint of the fingers.* While rupture of the extensor tendon over the joint between the middle and proximal phalanges of the fingers is not a common injury, the anatomical arrangement of the aponeurosis at this place and the typical deformity produced make it an interesting study. The whole question has been studied exhaustively by Hauck (1923). The tendons or the common extensors (Fig. 4), on approaching the metacarpophalangeal joint spread out fanlike and over the proximal phalanx of the finger divide into a central and two lateral bands. The central slip inserts along with the capsule of the joint into the base of the middle phalanx and sends a loose tendinous attachment to the proximal phalanx. The lateral slips pass to either side around the proximal interphalangeal joint converge over the middle phalanx distal to the proximal interphalangeal joint and insert into the joint capsule of the distal interphalangeal joint and base of the terminal phalanx. The interosseus and lumbrical tendons fuse with these three slips distal to the metacarpophalangeal joint. The triangular expansion of the interosseus lumbricalis insertion into the dorsal aponeurosis may be divided into two portions—a deep and a superficial. The su-

perficial fibers run into the middle portion of the dorsal aponeurosis in such a fashion that the more proximal run almost transversely and the distal more and more obliquely as the joint is approached. The deeper portion also runs transversely in its proximal part, becoming more and more oblique as the tendinous sheet is followed distally, and ends in the region of the proximal interphalangeal joint. Both superficial and deep portions of the interosseus lumbricalis tendons with the exception of a few distal fibers which insert into the joint capsule of the first interphalangeal joint, end in the lateral slips of the dorsal aponeurosis. In this manner the extensor tendon is strengthened both at its insertion into the middle phalanx and at its insertion into the distal phalanx by the tendons of the lumbricals and interossei. Although controversy exists as to whether fibers from the extensor tendon actually reach the distal phalanx, Hauck's views supported by many anatomists appear to be correct to us, viz. that the extensor tendon through its lateral slips gains attachment to the distal phalangeal bone.

The action of the extensor and lumbrical interosseus tendons on the finger is quite complicated. The dorsal tendon can extend the finger in all its joints unaided by the lumbricals and interossei but when the metacarpophalangeal joint passes from complete extension to hyperextension a flexion of the proximal and terminal interphalangeal joints occurs unless the interossei and lumbricals are brought into play. Hauck by an

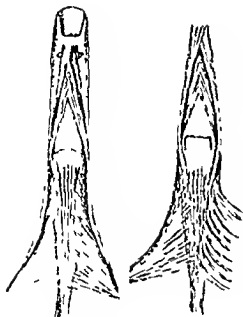


Fig. 4. 1. left. The dorsal aponeurosis from the upper surface—the lateral fibers coming in from the lumbrical and interosseous muscles spread out fanlike to end in the central and lateral portions of the extensor aponeurosis. The majority of the central slip of the aponeurosis end in the distal part of the proximal interphalangeal joint capsule—tear of this insertion would permit herniation of the joint through a buttonhole like defect. B. The dorsal aponeurosis seen from the under surface. From C. Husck.

ingenious model (Fig. 5) and by experiments on cadavers, has shown that this may be explained upon a purely mechanical basis. At first when pull is exerted upon an extensor tendon the traction is exerted upon the distal and middle phalanges which extend along with the metacarpophalangeal joint until full extension has been obtained in all the joints. However as soon as the tendon pull on the proximal phalanx has taken up all the slack in the loose tendon attachment the whole pull of the extensor tendon is transferred here allowing the distal portion to loosen and slight flexion to occur. These observations I have confirmed on cadaver hands. Although the joints in preserved material are not especially flexible it can be easily demonstrated that the pull exerted on the distal phalanx by force exerted on the extensor tendon is less when the finger is hyperextended than when the finger is flexed. In the living hand especially in such conditions as ulnar paralysis in which the lumbricals and interossei are not functioning this mechanism is beautifully illustrated particularly with reference to the ring and little fingers (Fig. 6). In the nor-

mal hand the extension of the two distal phalanges is accomplished by the extensor tendon and the lumbrical and interosseous tendons. When the proximal phalanx has been hyperextended actively, however, the two distal phalanges are extended by the latter two muscles, the extensor tendon no longer being able to do so.

The rupture of the dorsal aponeurosis over the proximal interphalangeal joint is due to either direct or indirect trauma. The middle finger is the most frequently affected though several cases have been reported in which the fifth finger was involved. The right hand is more frequently affected than the left. As to type of trauma two fairly definite etiological agents are present. In the one instance the fingers are being actively extended and a blow or a fall leads to forceful passive flexion. In the other type, and this seems the more frequent, a blow strikes the first interphalangeal joint while it is flexed. It would seem that the taut tendon is caught between the traumatizing agent and the bone and breaks or tears across. It is the middle portion of the dorsal aponeurosis which ruptures, the two lateral slips now loosened from their attachment about the joint slip volarward and the joint comes to lie between them as in a button hole. The volar dislocation is further increased by the pull of the lumbrical and interosseous muscles. The finger assumes then a typical deformity as shown in the accompanying photograph (Fig. 7) i.e. extension or hyperextension of the distal phalanx, flexion of the middle phalanx and extension or even hyperextension of the proximal phalanx. The deformity is increased by anything leading to increased tension of the extensor tendons, active extension of the fingers or passive flexion of the wrist. Diminution of the tension of the extensor tendons causes a certain diminution of the deformity. Attempts at extension of the middle phalanx cause pain about the proximal interphalangeal joint and a sense of spring like rigidity along the side of the middle phalanx. Similarly flexion of the distal phalanx causes pain about the proximal interphalangeal joint and the same sense of a spring like tension. On making a fist the finger can be flexed almost to normal so that the tip almost but not quite touches the palm, however as soon as the finger is extended the hyperextension of the distal phalanx recurs before the metacarpophalangeal joint is entirely extended.

The deformity appears at the moment the injury is sustained and is associated with pain and immediate swelling. The pain subsides but the swelling does not entirely disappear. Functional disturbance as far as the finger itself is concerned



FIG. 5 G Hauck's patented model to illustrate the action of the extensor tendons on the fingers. The interosseous lumbrical tendon is shown by dotted line in I. (This latter tendon has an insertion into the base of the proximal phalanx; this is not shown.) It is easily seen how

rupture of the extensor insertion into the base of the middle phalanx would allow the lateral slips of the tendon to be displaced volarward, thus causing the typical deformity of flexion of the proximal interphalangeal joint and extension of the distal interphalangeal joint.

is considerable though the uses to which the hand may be put would determine the degree. The roentgen ray usually shows no bony injury, though in a case observed by us (Fig. 7) an irregular shadow proximal to the joint showed the after result of a periosteal tear.

The condition responds well to operative treatment, though full free movements can scarcely be promised. When an incision is made over the joint the capsular tear is usually evident, the joint cavity being frequently opened up. In case of old injury, however, scar tissue may be present and conceal the location of the tear. The joint projects upward between the two lateral slips which are displaced volarward. In the repair the middle slip is sutured back into position after the lateral slips have been brought back dorsally to relieve the tension. Following this sutures are placed across the bone approximating the lateral slips to the midline to correct the volar dislocation. The finger should be kept in a splint in extension for 4 weeks after which active and passive movements and physical therapy should be instituted.

*Dislocation of the dorsal tendons over the metacarpophalangeal joints.* This rare condition in which the dorsal tendon slips to one side of the head of the metacarpal bone or in which a button-hole luxation of the joint through the tendon is present has been recently studied by Levy who following Maydl's classification divided the instances into the traumatic and the pathological dislocation. But 6 cases of undoubtedly traumatic dislocation could be found by Levy. The pathological type due to deforming arthritic changes about the joints or to some central nervous system disturbance associated with paralysis appears to be the more frequent. In a case of Levy's the condition was apparently congenital—the pa-

tient a medical student, could voluntarily dislocate the extensor tendon to the right middle and ring fingers; the girl's father could do likewise with the right and left middle fingers, and her paternal grandmother was said to have the same disability. Ritschl's case of button-hole dislocation of the metacarpophalangeal joint of the little finger through the extensor aponeurosis appears to be the best known. Too few cases are on record to make any worthwhile comments on the incidence of sex, age, or various tendons. The pathology appears to be little understood in the traumatic cases; some claim the binding apparatus between the tendon and the metacarpal and first phalanx is torn; others that the juncture tendinum is torn across. In the button-hole dislocation the same traumatic factor probably obtains as in other dorsal tendon ruptures and dislocations. Tearing off of bits of bone along with the tendinous attachment has been suggested by Levy.

Few symptoms are caused, weakness and easy tiring of the finger are noted. During flexion the tendon may be felt to snap down onto the side of the metacarpal head and there results some difficulty in extending the finger. Pain and some tenderness are present in the traumatic cases.

In early cases splinting in extension may lead to restoration of function to normal; with older cases, however, operative treatment is necessary; the dislocated tendon must be brought into position and held there by means of fascial bands over the head of the metacarpal and to the neighboring tendon. Iselin used tendon transplants for the connective tissue between the tendons. At times the juncture tendinum is too lax and should be shortened.

*Rupture of tendons at the wrist.* Inasmuch as normal tendon will not rupture without considerable trauma, spontaneous tendon rupture must

Opposite of the first interosseous tendon the middle phalanx and distal interphalangeal joint are shown in Figure 5.

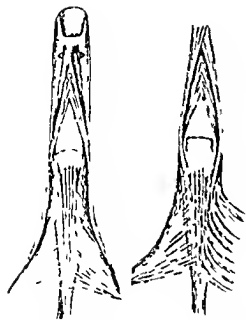


Fig 4. A left The dorsal aponeurosis from the upper surface—the lateral fibers coming in from the lumbrical and interosseous muscles spread out fanlike to end in the central and lateral portions of the extensor aponeurosis. The majority of the central slip of the aponeurosis end in the distal part of the proximal interphalangeal joint cap like a tear of this insert in would permit herniation of the joint through a buttonhole like defect. B The dorsal aponeurosis seen from the under surface. From G. Hauck.

ingenious model (Fig 5) and by experiments on cadavers has shown that this may be explained upon a purely mechanical basis. At first when pull is exerted upon an extensor tendon the traction is exerted upon the distal and middle phalanges which extend along with the metacarpophalangeal joint until full extension has been obtained in all the joints. However as soon as the tendon pull on the proximal phalanx has taken up all the slack in the loose tendon attachment the whole pull of the extensor tendon is transferred here allowing the distal portion to loosen and slight flexion to occur. These observations I have confirmed on cadaver hands. Although the joints in preserved material are not especially flexible it can be easily demonstrated that the pull exerted on the distal phalanx by force exerted on the extensor tendon is less when the finger is hyperextended than when the finger is flexed. In the living hand especially in such conditions as ulnar paralysis in which the lumbricals and interossei are not functioning this mechanism is beautifully illustrated particularly with reference to the ring and little fingers (Fig 6). In the nor-

mal hand the extension of the two distal phalanges is accomplished by the extensor tendon and the lumbrical and interosseous tendons. When the proximal phalanx has been hyperextended actively, however, the two distal phalanges are extended by the latter two muscles; the extensor tendon no longer being able to do so.

The rupture of the dorsal aponeurosis over the proximal interphalangeal joint is due to either direct or indirect trauma. The middle finger is the most frequently affected, though several cases have been reported in which the fifth finger was involved. The right hand is more frequently affected than the left. As to type of trauma two fairly definite etiological agents are present. In the one instance the fingers are being actively extended and a blow or a fall leads to forceful passive flexion. In the other type and this seems the more frequent a blow strikes the first interphalangeal joint while it is flexed. It would seem that the taut tendon is caught between the traumatizing agent and the bone and breaks or tears across. It is the middle portion of the dorsal aponeurosis which ruptures; the two lateral slips now loosened from their attachment about the joint slip volarward and the joint comes to lie between them as in a button hole. The volar displacement is further increased by the pull of the lumbrical and interosseous muscles. The finger assumes then a typical deformity as shown in the accompanying photograph (Fig 7). i.e. extension or hyperextension of the distal phalanx, flexion of the middle phalanx and extension or even hyperextension of the proximal phalanx. The deformity is increased by anything leading to increased tension of the extensor tendons, active extension of the fingers or passive flexion of the wrist. Diminution of the tension of the extensor tendons causes a certain diminution of the deformity. Attempts at extension of the middle phalanx cause pain about the proximal interphalangeal joint and a sense of spring like rigidity along the side of the middle phalanx. Similarly flexion of the distal phalanx causes pain about the proximal interphalangeal joint and the same sense of a spring like tension. On making a fist the finger can be flexed almost to normal so that the tip almost but not quite touches the palm; however as soon as the finger is extended the hyperextension of the distal phalanx recurs before the metacarpophalangeal joint is entirely extended.

The deformity appears at the moment the injury is sustained and is associated with pain and immediate swelling. The pain subsides but the swelling does not entirely disappear. Functional disturbance as far as the finger itself is concerned



Fig 7 Typical deformity resulting from rupture of the extensor tendon over the proximal interphalangeal joint. The fully and strongly actively extended left ring finger was struck on the tip by a swift basketball. The roentgenograms show a bony proliferation due either to tearing, away of periosteum or a chipping fracture.



Fig 8 Deformity resulting from open division of the extensor tendon over the proximal interphalangeal joint. This deformity is exactly similar to that following subcutaneous rupture at the same location. The proximal interphalangeal joint rested in flexion with active motion possible between extension to 135 degrees and flexion to 90 degrees. The distal interphalangeal joint was extended to 180 degrees and could be flexed about 15 degrees. Operation revealed division of the extensor insertion into the middle phalanx and partial division and volar displacement of the radial slip of the extensor tendon.

of the dorsum of the forearm obliquely across the lower end of the radius and carpus crosses over the extensor carpi radialis longus and brevis which separate it from the carpal bones and, running over the medial and the dorsal surfaces of the first metacarpal reaches the dorsum of the phalanges and inserts into the base of the distal phalanx of the thumb. It is covered by an individual sheath from a point just proximal to the dorsal carpal ligament to the region of the head of the first metacarpal. Over the dorsum of the lower end of the radius it passes through a groove bounded on each side by osseous ridges to which the dorsal carpal ligament is attached which thus completes a dense osseo-ligamentous tunnel in which the tendon is confined. It forms the medial boundary of the anatomical snuff box (or *tabatiere*), the lateral boundary of which is formed by the extensor pollicis brevis and abductor pollicis longus. The extensor pollicis longus is an abductor of the thumb and its metacarpal extensor of the phalanges of the thumb. It assists the extensor pollicis brevis in extending the proximal phalanx but forms the sole extensor of the distal phalanx. A certain intermingling of fibers of the two thumb extensors takes place over the proximal phalanx. The tendon is covered by a tendon sheath as already described but a mesotenon is present through but a limited part of this sheath. It has

been pointed out by Rau, Weigeldt, and others that after the age of 25 years the vascular supply to the tendon becomes progressively diminished. In its course the tendon is subject to two sharp turns both of which are at the distal end of the dorsal carpal ligament. One of these turns is in a horizontal plane as the tendon curves laterally from the groove on the radius about the distal end of the ridge forming the lateral border of the groove. The other turn is in a sagittal plane at the distal end of the dorsal carpal ligament. This latter change in direction is present only when the wrist is dorsiflexed. These are the essential factors which predispose to chronic tenosynovitis as result of use or trauma.

As studied first by Duems the condition was known as *Trommlerlähmung* (drummer's palsy) or *Trommлерsehne* (drummer's tendon) from the fact that the drummers in the German army were long known to be subject to a peculiar paralysis of the distal phalanx of the left thumb. Duems showed that the condition was not due to a paralysis of the long extensor of the thumb but to rupture of the tendon. Since then a few other occupations have been shown to predispose to the condition. Among these occupations may be noted that of waiters, tailors (Hunt), furniture polishers, carpenters (Barnes), rubber workers, and wood carvers. It is to be noted that these are all occupations calling for voluntary rather rigid

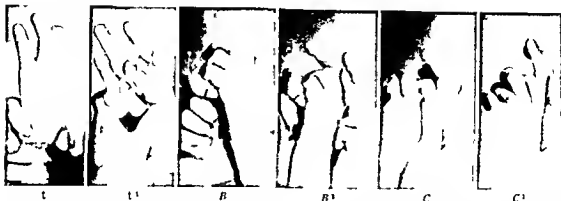


FIG. 6. Photographs of the left hand of a patient with an ulnar paralysis to show the mechanism of action of the extensor tendons. *t* Limits of extension of fingers with some hyperextension of the metacarpophalangeal joints. *t'* When these joints are slightly flexed there is an increased power of extension of the interphalangeal joints.

*B* and *B'* and *C* and *C'* show the same phenomena in the middle and ring fingers respectively. In *B* and *C* the fingers are extended as far as possible. *B'* and *C'* show the degree of extension possible when the metacarpophalangeal joint is slightly flexed by digital pressure when the patient is attempting to actively extend the finger.

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Case 1, flexor digitorum sublimis and profundus to the index finger. Case 3, flexor digitorum sublimis and profundus to the ring and little fingers. Case 4, flexor digitorum sublimis to the fifth finger. Case 5, flexor digitorum sublimis to the little finger. Case 7, a slip of the flexor digitorum sublimis to the index finger. Case 9, flexor digitorum profundus to the index and middle fingers. Case 10, flexor digitorum sublimis and profundus to the little finger. In three instances extensor tendons were involved. Case 2, the extensor pollicis brevis. Case 6, all extensor tendons were thin wavy and thread like. Case 8, the extensor pollicis longus and brevis.

In most instances it has been possible to suture the ruptured tendon to adjacent tendons and secure good return of function as shown in case reports at the end of this paper. In a case recently operated upon by Dr. Kanavel however both extensors of the thumb had been destroyed and it was necessary to graft a tendon from the foot into the defect in the extensor pollicis longus (Fig. 10). This graft was removed as shown in Figure 9 and the hand put up with the thumb in extreme extension. Healing took place by primary intention and 2 months after operation (Fig. 11) the function of the thumb was perfect.

With other conditions such as gonorrhea typhus fever lues gout or deforming arthritis leading to tendon rupture the author has had no personal experience. Tumors of tendons (Odermatt) may also lead to rupture though their great rarity makes this a very remote possible cause for spontaneous rupture.

Trauma is by far the most frequent cause for so called spontaneous rupture and inasmuch as but one tendon appears to be at all frequently affected the rupture of this tendon may be discussed. Spontaneous rupture of the extensor pollicis longus was first studied in the German army (Duerns) where it had long been looked upon as an isolated paralysis. The traumatic moment which is responsible for the condition may be either chronic irritative trauma or a single injury. A knowledge of the anatomy of this particular tendon explains the tendency to spontaneous rupture and of course the functional disability resulting therefrom. The tendon of the extensor pollicis longus passes from medial to lateral side



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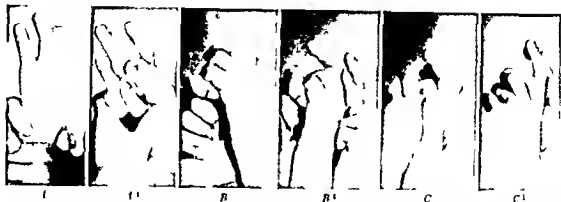


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longus tendon and crushing of this tendon against the dorsal carpal ligament. Tearing and separation of tendon fibers occur as well as tears through the tendon sheath and interference with the blood supply. That some such factor must be present is further substantiated by the fact that often at operation no change in the bony groove is found, no radial or ridge fracture is present, and no displacement of the tendons demonstrated. The secondary factor is more important probably than the primary one for despite the numerous wrist injuries few tendon ruptures occur. This factor (Wiegandt) is the vascular supply of the tendon, no mesotenon being present over a considerable length of its course. After the age of 25 the vascular supply to the tendon is considerably diminished. This factor is important when we consider that most cases occur after the age of twenty-five.

Histologically the picture is that of an aseptic necrosis. The tendon fibers are swollen, the nuclei and fibers stain poorly, and considerable hyalinization is present. No inflammatory changes are noted.

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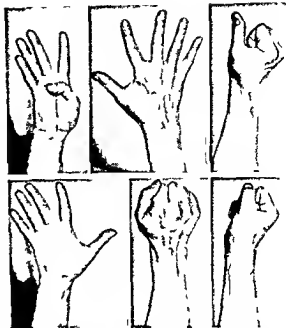


FIG. 11 Same patient as in Figure 10. These photographs show the free function of the thumb a month after a graft was made to replace the destroyed segment of the extensor pollicis longus. The strong tendon is shown forming the ulnar boundary of the tabetiere.

that is at the distal end of the dorsal carpal ligament and the trauma leading to it is quite minimal, as a rule no excessive use of the thumb has preceded the condition, the individual going about his usual work. A very few instances have followed heavy lifting these are exceptions. Sewing, picking apples, putting the hand in the trousers pocket, using a scissors, and other household occupations appear in the reported histories. There is sudden usually painless loss of function in the thumb. In a few instances a cracking sound preceded the functional loss, in some moderately severe pain accompanied it and in one reported case a severe muscular cramp came on just before the loss of tendon function. Some swelling appears afterward but this is often of very moderate degree. The functional loss is typical and examination of the hand should lead to recognition of the underlying cause for the deformity. The medial border of the anatomical snuff box is gone due to the separation of the ends of the tendon. The distal phalanx of the thumb is flexed and can be extended only if the thumb is adducted and the metacarpal flexed into the palm at which time the abductor brevis and flexor pollicis brevis acting on the dorsal aponeurosis may cause some

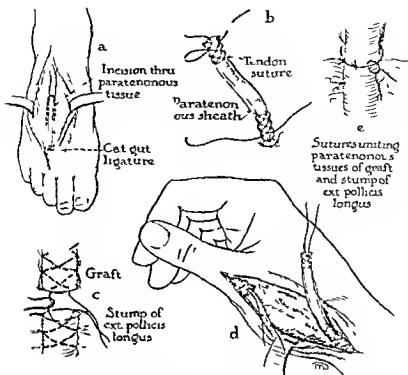


Fig. 9. Tendon transplantation for repair of extensor pollicis longus destroyed by tuberculosis. *A* Extensor tendon of foot exposed leaving paratenonous tissues about it. Longitudinal incisions are made to either side of the tendon through the paratenonous tissues. At either end of these incisions catgut ligatures are passed around the tendon and tied in order to keep the tissues attached to the tendon. *B* Sutures passed through tendon and paratenonous tissues. After the suture is made the catgut ligature and the tendon it surrounds are excised. *C* and *F* Detail of suture lines. In *E* the union of paratenonous tissues is shown. *D* Suture at proximal line completed.

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When division follows a single injury the case is somewhat different. Here we have to deal with but one trauma, not repeated trauma which so disturbs the structure of the tendon that it leads to eventual rupture. The trauma which most frequently leads to spontaneous rupture is frac-

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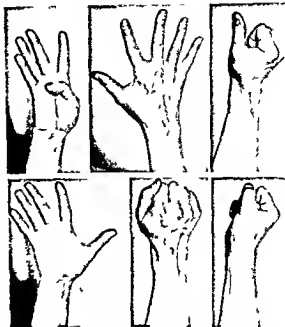


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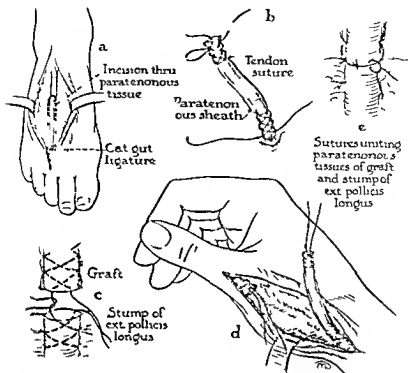


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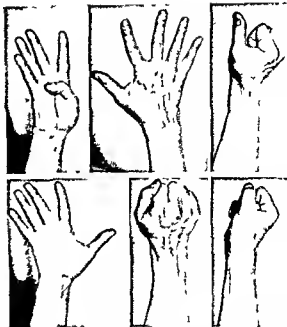


FIG. 11 Same patient as in Figure 10. These photographs show the free function of the thumb 3 months after a graft was made to replace the destroyed segment of the extensor pollicis longus. The strong tendon is shown forming the ulnar boundary of the tabetiere.

that is at the distal end of the dorsal carpal ligament and the trauma leading to it is quite minimal. As a rule no excessive use of the thumb has preceded the condition, the individual going about his usual work. A very few instances have followed heavy lifting, these are exceptions. Sewing, picking apples, putting the hand in the trousers pocket, using a scissors, and other household occupations appear in the reported histories. There is sudden, usually painless, loss of function in the thumb. In a few instances a cracking sound preceded the functional loss, in some moderately severe pain accompanied it and in one reported case a severe muscular cramp came on just before the loss of tendon function. Some swelling appears afterward but this is often of very moderate degree. The functional loss is typical, and examination of the hand should lead to recognition of the underlying cause for the deformity. The medial border of the anatomical snuff box is gone due to the separation of the ends of the tendon. The distal phalanx of the thumb is flexed and can be extended only if the thumb is adducted and the metacarpal flexed into the palm at which time the abductor brevis and flexor pollicis brevis acting on the dorsal aponeurosis may cause some

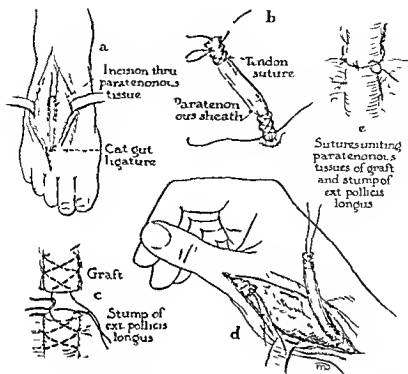


Fig. 6. *a* Tendon transplantation for repair of extensor pollicis longus destroyed by tuberculous. *b* Extensor tendon of foot exposed leaving paratenonous tissues about it. Longitudinal incisions are made to either side of the tendon through the paratenonous tissues. At either end of these incisions catgut ligatures are passed around the tendon and tied in order to keep the tissues attached to the tendon. *b* Sutures passed through tendon and paratenonous tissues. After the suture is made the catgut ligature and the tendon it surrounds are excised. *c* and *e* Details of suture lines. In *f* the suture of paratenonous tissues is shown. *d* Suture at proximal line completed.

fixed position of the hand. The drummer grasps the stick (in the left hand) between the thumb and the second metacarpal while the vibratory motion of the stick leads to continuous highly frequent movements of the tendon of the thumb. The same factors are present in the other occupations named. According to Dittrich the trauma to the tendon occurs over the distal end of the dorsal carpal ligament as suggested by Duems or over the osseous ridge of the radius—Steudel zur Verth. Excessive use of the tendon with its angulation leads to a chronic tenosynovitis with pain and swelling. The chronic aseptic inflammation continues with persistence of the trauma and leads to eventual division of the fibers.

When division follows a single injury the case is somewhat different. Here we have to deal with but one trauma, not repeated trauma which so disturbs the structure of the tendon that it leads to eventual rupture. The trauma which most frequently leads to spontaneous rupture is frac-

ture of the radius. Ashhurst remarks that in view of the anatomy of Colles' fracture the disability should really occur more frequently than it does. Honigsmann in 24 cases of tendon rupture following wrist injury found 18 occurred after radius fracture at the wrist, 1 after lunate fracture and 5 after sprain with no demonstrable bony injuries. In such instances two primary factors are present. Hauck suggests that the wrist injury (fracture or sprain) leads to some displacement of the tendon due to bony changes in its canal or ligamentous tears. But as Honigsmann and Oederhoff as well as Hauck have noted, displacement is not always present nor fracture demonstrated, and a primary injury to the tendon at the time that the trauma was received must be assumed. Dittrich suggests that the tendon is crushed over the angulation and that this sets up a chronic tendinitis. Falls on the outstretched palm with hand and thumb extended and with the muscles contracted lead to increase in the angulation of the extensor pollicis

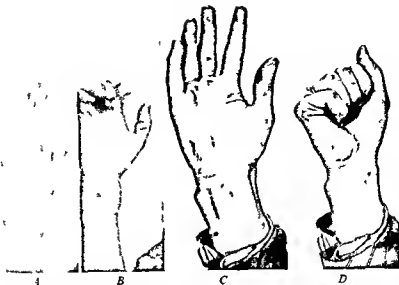


FIG. 14. Tuberculous tenosynovitis of right wrist. Destruction of flexor digitorum sublimis tendons to ring and little fingers. A and B show limits of function of hand before operation. C and D show the result two and one half years later.

tient was thrown from a horse while grasping tightly to the horn of the saddle. The deep flexor of the left little finger ruptured over the middle phalanx. The terminal phalanx could not be flexed. On operation the proximal end of the tendon was found curled up in the tendon sheath at the base of the finger. In Lessing's case the patient fell on the outstretched hand rupturing the flexor profundus tendon of the ring finger. Though as a rule the rupture occurs on the finger the tear may occur anywhere along the course, in Thorn's case the rupture was found in the wrist.

The following two cases are worthy of report.

M. G. (patient of Dr. Allen B. Kanavel) a young man of 25 was struck on the tip of the fully extended right middle finger by a swiftly traveling baseball. The distal phalanx was dislocated dorsally and was reduced by the patient at the time with an audible snap. A splint was applied and left on for 6 days. On its removal the patient was unable to flex the terminal phalanx and there was no improvement following physical therapy. Six months later examination showed (Fig. 12) complete function in the proximal interphalangeal and metacarpophalangeal joints but inability to flex the distal interphalangeal joint. There was considerable diminution of passive flexion in the distal interphalangeal joint. The operation showed the profundus tendon completely torn loose from its insertion into the distal phalanx. There was marked periarthral fibrosis. The sublimis tendon was bound down by adhesions to the proximal interphalangeal joint. The profundus tendon was released from adhesions and sutured with silk to the peroneum over the distal phalanx and the finger splinted in flexion. The end result (4½ years later) is not entirely satisfactory due to the fibrosis about the joint resulting from the associated dislocation.

The second patient presents a rather puzzling story. He had been operated upon twice before Dr. Sumner L.

Koch saw him and the original pathological picture was thus obscured. A healthy man of 40 years 8 years previous to entrance suffered an injury to the right thumb while buckling an overshoe. Immediately after the injury he was unable to flex the distal phalanx of the thumb. He did nothing for this condition for several years despite the disability. Four years ago he consulted a surgeon who operated upon the thumb and found the flexor pollicis longus tendon movable laterally over the base of the proximal phalanx. The tendon was split and sutured to the base of the proximal phalanx. There was no improvement following this operation. Three years later he was operated upon again and the surgeon told him that the tendon was broken in the region of the proximal phalanx. An end to end suture of the tendon was performed and resulted in a 20 degrees power of flexion of the distal phalanx. In July 1918 he consulted Dr. Koch who found a dense scar over the ulnar and palmar surface of the thumb. Flexion of the distal phalanx of the thumb was possible for 15-20 degrees but there was obvious adherence to this scar. At operation the flexor pollicis longus tendon was found degenerated at its distal end for some 2½ inches and markedly adherent to the proximal phalanx. It was not possible at this time to determine the original pathological process. The thick skin scar was excised and the degenerated tendon replaced by a tendon graft taken from the dorsum of the foot and secured to the distal phalanx by passing it through a drill hole in the bone. Six months after operation the patient states that the thumb is reasonably strong and can be used in grasping but that the tendon seems to be too short and interferes with extension.

#### RÉSUMÉ OF CASE HISTORIES OF PATIENTS WITH RUPTURE OF TENDONS

##### *Rupture of Extensor Tendons on Distal Phalanx of the Fingers*

CASE 1. J. L. (W 117636) Female, aged 50 years. The injury occurred during the removal of stockings. The tips



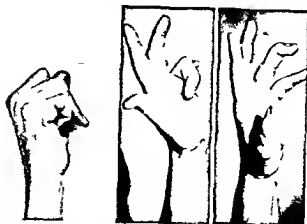


Fig. 12. left Rupture of flexor digitorum profundus tendon from its insertion in the distal phalanx of the right ring finger. Operative repair 6 months after the injury was only partially successful due to the great amount of peri articular fibrosis following associated dorsal dislocation.

Figs. 23 Typical deformity of the left ring finger following rupture of the extensor tendon at its insertion into the distal phalanx. The finger is shown in complete flexion and extension.

extension. The last phase of extension of the proximal phalanx and of the first metacarpal is also lost. Abduction and adduction of the thumb are weakened. The thumb cannot be brought to the radial side of the index finger but is displaced somewhat volarward (Hauck). Rarely the two ends of the tendon may be felt over the meta carpal and under the dorsal carpal ligament.

Operative repair is the only treatment worth considering. Splinting in hyperextension has never lead to spontaneous repair. On opening the canal and sheath the tendon ends will be found frayed and brush like, yellowish white in color and often quite soft. Except in very recent cases the great displacement cannot be overcome by pulling on the ends or extension of the wrist. This fact, together with the necrosis of the ends makes end to end suture difficult or impossible. The tendon stumps are so changed here that they are not suitable for any plastic work. The tendon may be lengthened by one of the various operations described for this procedure and in this fashion suture may be possible. Suture of the distal end to a slip split from the extensor carpi radialis longus has long been practiced and has given some good results. In some instances success has been attained by suturing the two stumps to an adjacent tendon. After union of the stumps with the tendon has taken place the operative field is again exposed and the adherent stumps with their uniting section of normal tendon are

separated longitudinally from the sound tendon. Replacement of the tendon by silk catgut or preserved tendon may also be tried. Silk seems to be best for this service. Autoplastic tendon grafts are however the most logical means of closing the gap between the two divided ends. This graft may be taken from the dorsum of the foot or from the palmaris longus should be sutured into place after careful trimming of the ends of the injured tendons, and should be surrounded by its own paratenon (Fig 9). It is probably not necessary to repair the dorsal ligament. Other types of autoplastic grafts fascial, arterial, venous or the cutis strips as used by Rehn present no advantage over tendon and lacking paratenon are probably not so good.

Whatever the technique used to secure union the thumb should be held out in complete extension by means of plastic or aluminum splints for 2 or 3 weeks after which active and passive motion combined with physical therapy should be started. The functional results appear to be quite good.

#### RUPTURE OF FLEXOR TENDONS

Traumatic subcutaneous rupture of the normal flexor tendon is extremely rare. We have seen but two cases and only a few have been reported (Schlatter, Stapelmohr). It appears to follow a sudden extension of a tightly flexed finger as in the case reported by Schlatter in which the pa-

was carefully dissected away and the ends of the extensor pollicis brevis were sutured. Eight years later the patient had excellent use of the hand and no evidence of return of the process.

CASE 3 M S (W 103348) Female aged 26 years. Tuberculous tenosynovitis of the right wrist and palm. The process began as a flexion deformity of the little finger some 10 years previous to operation. Later a swelling appeared on the wrist and palm associated with much pain which radiated up the forearm. Except for the flexion contracture of the ring and little fingers there was no motor disability. The tuberculous process was found to have involved the ulnar bursa and to have spread into the midpalmar space. The flexor tendons of the ring and little fingers were fragmented and threaded and after removal of the tuberculous tissue it was necessary to suture them. No reply to numerous inquiries.

CASE 4 W T C (W 127774) Male aged 50 years. Tuberculous tenosynovitis of the flexor tendons of the left wrist. There was extensive involvement with marked infiltration and thickening. The flexor digitorum sublimis to the little finger had been completely divided by the process while several other tendons especially the flexor pollicis longus were badly fragmented. All the tuberculous tissue was carefully dissected away and the distal stump of the divided tendon sutured to the corresponding tendon of the ring finger. The patient made an uneventful recovery but died 2 months later from a cardiac attack.

CASE 5 P M (W 117167) Female aged 33 years. Massive tuberculous tenosynovitis of the right wrist (Fig. 14) which began with swelling of the little finger and wrist 10 years previously. There was considerable pain and numbness and the patient could not completely flex the fingers. At operation the sheaths of both radial and ulnar bursae were found to be markedly thickened and infiltrated with grayish red granulation tissue. The flexor digitorum sublimis tendons to the little and ring fingers were destroyed from a point just proximal to the wrist downward to the middle of the palm. The tuberculous tissue was removed the sublimis tendon of the ring finger sutured to that of the middle finger and the sublimis of the little finger sutured to its profundus tendon. Healing occurred *per primam*. Two and one half years later the anatomical function was perfect (Fig. 14).

CASE 6 O P (W 122957) Male aged 31 years. Tuberculous tenosynovitis of the dorsum of the left wrist. The process began 3 years previously following an injury and had been operated upon twice elsewhere without results. There was slight impairment of extension of the wrist and fingers. At operation there was found extensive involvement of all the sheaths on the dorsum of the wrist. There were no ruptured tendons but all were remarkably small some thread like. The tuberculous tissue was all dissected away and the incision closed. Healing *per primam*. No reply to follow up letters.

CASE 7 G K (W 130029) Tenosynovitis of the sheath of the flexor tendons of the index finger. Five months previously the patient cut the finger with a piece of glass. The wound healed properly but a month later began to cause pain and swelling developed which has persisted. There was some slight impairment in flexion of the finger. At operation the sheath of the flexor tendons was found to be infiltrated by a mass of soft tuberculous granulation tissue. One slip of the flexor digitorum sublimis was infiltrated for a distance of an inch and this along with the other tuberculous tissue was removed. Healing took place by first intention and with physical therapy full function returned.

CASE 8 B M (W 134930 137,99 P, 98) (Figs 10 and 11) Tuberculous tenosynovitis of all tendons on the

dorsum of the right wrist. Two and one half years previous to admittance to the hospital the patient sprained the wrist following which a walnut sized lump developed. Three operations had been performed previously for removal of this mass but each time it had recurred. Upon examination there was found a tense irregular nodular swelling lying over the extensor tendons on the wrist. This was found to be tuberculous at operation and was cleanly dissected. The wound healed well and the man returned to work with free use of the hand. Four months later a recurrence about the extensor pollicis longus and brevis and abductor pollicis longus was excised and at this time the tendon of the extensor pollicis longus was found to be slightly invaded. The tuberculous tissue was excised and the involved strip of extensor pollicis longus was excised. Healing was prompt but recurrence took place 22 to 14 months later. At the third operation the extensor pollicis brevis was found to have been entirely destroyed and the extensor pollicis longus so involved that a large section had to be removed. This was replaced by a graft taken from the dorsum of the foot. The thumb was functioning perfectly 2 months after operation (Fig. 11).

CASE 9 W Cr (W 141304) Male aged 58 years. Tuberculous tenosynovitis of both wrists on flexor surface. The process began with pain and swelling in the left hand 3 years ago and has slowly increased since the onset. He cannot fully extend the fingers but there is no loss of movement. At operation on the right hand the deep flexors to the index and middle fingers were found to be invaded and partially destroyed and the sublimis tendons to the same fingers were somewhat infiltrated. There was some involvement of the radiocarpal joint. After removal of the tuberculous tissue the distal stumps of the profundus tendons to the index and middle fingers were sutured to the sublimis tendons of the same fingers. (The left hand was operated upon later but the tendons were not invaded.) Healing occurred *per primam* and excellent function resulted.

CASE 10 R W (W 142434 144308) Female aged 28 years. Tuberculous tenosynovitis of right wrist. The condition began a year previously with intermittent pain and swelling of the wrist. Gradually the swelling reached the palm and volar surface of the thumb since which time the swelling has not receded. There was considerable limitation of motion in the fingers and thumb but no movement was lost except flexion of the interphalangeal joints of the fifth finger. At operation considerable involvement was found to be present. The radial bursa was invaded distally to the insertion of the flexor pollicis longus the ulnar bursa well into the palm but not into the little finger and the sheath of the flexors of the index finger were found to be infiltrated. Both flexor tendons to the little finger had been destroyed in the wrist and their distal stumps were sutured to the adjacent tendons of the ring finger. The condition recurred above the wrist 5 months later and a second operation was necessary. Function was returning in the fifth finger at that time.

The writer is indebted to Dr. Allen B. Kanavel and Dr. Sumner I. Koch for permission to study and report the cases upon which this article is based.

## BIBLIOGRAPHY

- ADAMS J C An unusual amputation U States Nav M Bull 1929 xxvii 379-380  
 ASHLEY A P C Rupture of tendon of extensor longus pollicis following a Colles fracture Ann Surg 1923 lxxviii 398-400  
 BAYNE KOLAND Sehnenarrosse an der Hand Deutsche Zeitschr f Chir 1923 clxxxix 282-285

of the actively extended fingers were caught in the seam at the top of the hose. The patient heard a snap and experienced a sharp pain in the right middle finger. On examination he found she could no longer extend the distal phalanx. At operation 2 weeks following the injury the extensor tendon was found to have ruptured at the level of the joint. It was repaired with fine silk and the finger splinted in extension. In reply to an inquiry 1 year later the patient reported complete functional recovery (Fig. 5).

CASE 2 I D (W 137424) Male. The right middle finger was caught in a closing garage door in such a manner that both interphalangeal joints were sharply flexed. The typical deformity resulted immediately (Fig. 2). The injury was treated elsewhere on a splint in extension but on removal of the splint the deformity recurred at once. Operative repair of the ruptured tendon was performed several weeks after the injury, and the man wore a metal splint for a number of weeks. Final result not known.

CASE 3 H B (W 140720) Male aged 45. While rubbing a spot off the leather upholstery in his car the tip of the left index finger caught on a button or some other projection. The patient heard a snap and noted that the finger tip was flexed. He had been unable since then to extend the distal phalanx of the finger. A month and 10 days later he presented himself for treatment. The finger tip was flexed at about 120 degrees at rest and could be flexed to 90 degrees and extended back again to 120 degrees. There was motion through an arc of 30 degrees. On operation the extensor tendon was found to have torn loose from its attachment to the distal phalanx. The tendon had healed and pull upon it extended the distal phalanx. It was however too long to effect complete extension. Repair was done by making a step-cut incision through the tendon scar and overlapping the two stumps. The finger was then put up in hyperextension of the distal phalanx. Healing occurred *per primam*. Two months later the terminal phalanx could be extended to 170 degrees. Motions were still slightly stiff but improvement was looked for.

CASE 4 H R B (W 141453) Male aged 42. One month previously while taking an automobile tire from a high shelf he was struck on the tip of the left ring finger by the falling tire. There was no great pain associated with the accident but the finger tip was flexed and could not be extended. It was brought back into position and a splint applied but the deformity recurred as soon as the splint was removed. The typical deformity and degrees of movement of the finger are shown in Figure 13. At operation the tendon was found to have healed but in a lengthened state so that shortening was necessary. This was accomplished by dividing the tendon obliquely overlapping the ends and suturing them with silk. The finger was then placed in moderate hyperextension. Healing *per primam*.

#### *Rupture of Extensor Tendons of the Proximal Interphalangeal Joint*

CASE 5 S V (W 121475) Male aged 16. Three years previous to entrance into hospital the patient was struck on the end of the actively extended left ring finger by a swift baseball. This produced a sharp flexion of the finger at the proximal interphalangeal joint. It was immediately straightened out and placed in a splint which was left on for 6 days. On removal of the splint the deformity recurred but movement was so painful that he would allow no one to straighten the finger for several weeks. The pain gradually disappeared but the flexion deformity persisted. Upon examination 3 years following the injury the proximal interphalangeal joint of the left ring finger was found

to be flexed to a right angle (Fig. 7). The joint could not be actively extended but passive extension to an angle of 120 degrees was possible. Roentgen ray examination demonstrated an irregular shadow proximal to the joint which probably indicated a healed periosteal tear. At operation the tendon was found to be frayed over the joint and one ship displaced ulnarward. The displaced ship was brought to the midline where it was held by silk sutures. This procedure brought the joint into extension. The finger was then splinted in extension. We have received no answer to follow up letters.

#### *Rupture or Dislocation of Metacarpophalangeal Joint*

##### *No examples*

#### *Rupture of Extensor Tendons at the Wrist*

(See cases of tuberculous tenosynovitis)

#### *Rupture of the Flexor Tendons*

CASE 6 M G (W 109,62) (Reported in text.) Male of 28 was struck on top of right middle finger with base ball causing backward dislocation of distal phalanx. Came to operation 4 months later at which time the flexor digitorum profundus was found to have ruptured from its insertion. It was sutured in place.

CASE 7 W C (W 130436) Male aged 40 (Reported in text.) Injury to right thumb occurred eight years previously while bucking an overhoe. Rupture of flexor pollicis longus. Several operations performed previous to the time patient was seen by Dr. Sumner L. Koch. Last operation July 1928 at which time a graft was made replacing about 2 1/2 inches of the degenerated tendon. Six months after operation patient states that the thumb is reasonably strong and can be used in grasping but that the tendon seems to be too short and interferes with extension.

#### *Rupture of Tendons Due to Tuberculous Infiltration*

In ten instances taken from a series of cases of tuberculous tenosynovitis of the hand rupture of tendons had taken place or was impending.

CASE 1 S K (W 86002) Female aged 60 years. Tuberculous tenosynovitis of flexor tendon of the right hand. Gradual onset 2 years before operation with stiffness in the fingers later swelling on anterior surface of left wrist and forearm. For some time she had been unable to flex the interphalangeal joints of the index finger. There was found extensive involvement of the radial and ulnar bursa above the wrist extending distally into the tendon sheaths of the thumb and little finger. The sheaths were distended with clear yellow fluid and a homogeneous mass of granulation tissue in places caseous. The flexor tendons of the index finger had separated at the level of the transverse carpal ligament as if cut or broken. The severed ends still joined by a strand of fibrous tissue. After thorough removal of all tuberculous tissue the distal ends of the flexor tendons of the index finger were sutured to the corresponding tendon of the middle finger. The patient reported 8 years after the operation that function of the hand was excellent.

CASE 2 R S (W 94699) Male aged 28 years. Process began on the right wrist 10 months ago as slight swelling and pain which had gradually increased in size and severity. The tuberculous process was found to involve the sheaths of the extensor pollicis longus and brevis, abductor pollicis longus, extensor digitorum communis, extensor carpi radialis longus and brevis and the extensor digiti quinti proprius. The extensor pollicis brevis had been nearly separated by the process. The tuberculous tissue



Fig. 1

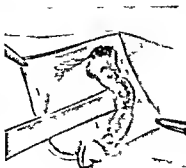


Fig. 2

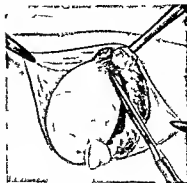


Fig. 3

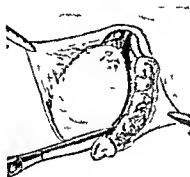


Fig. 4

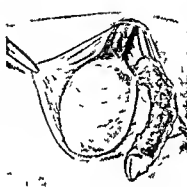


Fig. 5

Fig. 1 Scrotum grasped from above Elliptical cut about the tuberculous sinus subcutaneous tissue being divided by light concentric cuts

Fig. 2 Testicle entirely removed from scrotum Scrotum covered by gauze Tunica vaginalis opened Separation of midportion of epididymis

Fig. 3 Lobus major being separated from testicle by sharp dissection

Fig. 4 Separation of lobus minor

Fig. 5 Epididymis entirely separated from testicle

Fig. 6 Testicle and epididymis both wrapped in gauze Clamp pushed up along the vas Incision over tip of clamp

Fig. 7 Clamp passed down through small incision in groin Vas divided and carbolized Epididymis removed

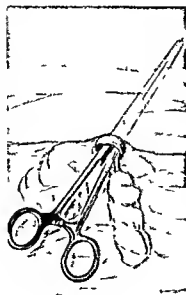


Fig. 6

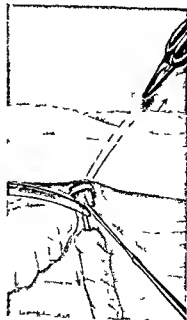


Fig. 7

- BARNE C. K. Spontaneous rupture of extensor pollicis longus. *J Am M Ass* 1926 lxxvii 663.
- DITTRICH LUDOLF Die Spierruptur der Sehne des Extensor pollicis longus eine typische Verletzung. *Beitr z klin Chir* 1924 cxxvii 150-154.
- DOLZ J. A. Handbuch der Militäerkrankheiten acussere (chirurgische) Krankheiten Leipzig, F. Teubold 1909-1900.
- DURBAN KARL Subkutane Rupturen von Fingerstrecksehne. Ein kasuistisches Beitrag. *Zentralbl f Chir* 1926 lvi 2773-4.
- DYKES S. N. Rupture of the extensor longus pollicis tendon. *Brit M J* 1922 i 347.
- GARDNER J. G. Rupture of the extensor longus pollicis tendon reported by Dr. Dykes. *Brit M J* 1922 i 4, 6.
- GLAS L. Metallschne zur Behandlung der Strecksehnenverletzung des Fingereckgelenks. *Zentralbl f Chir* 1927 lvi 302, 302A.
- HALLER GUSTAV Ueber die Rupture der Extensor pollicis longus Sehne nach typischem Kadaverbruch und ihre operative Behandlung. *Arch f klin Chir* 1923 cxxvii 81-91.
- Idem. Die Ruptur der Dorsalaponeurose am ersten Interphalangealgelenk, zugleich ein Beitrag zur Anatomie und Physiologie der Dorsalaponeurose. *Arch f klin Chir* 1923 cxxvii 107-232.
- HOFMANN ERNST Die traumatische Spierruptur der Sehne des langen Daumenstreckers. *Med Klin* 1926 xxii 719-31.
- HUNT J. R. Analysis of the ungual phalanx of the thumb from spontaneous rupture of the extensor pollicis longus the so-called drummers palsy. *J Am M Ass* 1915 lxi 1138-1140.
- KANAVEL ALLAN H. Tuberculous tenosynovitis of the hand a report of fourteen cases of tuberculous tenosynovitis. *Surg Gynec & Obst* 1923 xxvii 635-647.
- LEFF W. Ueber die Sehnenluxation der Fingerstrecker. *Zentralbl f Chir* 1921 xlviii 432-436.
- LEWIS JAMES A simple splint for baseball finger. *J Am M Ass* 1925 lxxv 1039.
- MACFARLANE A. S. Rupture of the extensor longus pollicis tendon. *Brit M J* 1922 i 476.
- MENDEL Spierruptur der Sehne des Extensor pollicis longus. München med Wchnschr 1923 lxxii 836.
- ONERHART W. Spontaner Spaltsehnenriss des langen Daumenstreckers eine typische Kombinationsverletzung mit Kadaverbruch oder Lunatum luxation oder Dislocation des Handgelenks. *Schweiz med Wchnschr* 1913 lxi 707.
- Idem. Operativ geheilte Ruptur der Sehne des Extensor pollicis longus. *Wien med Wchnschr* 1919 lxxix 707.
- Idem. Ueber die traumatische Ruptur der Sehne des langen Daumenstreckers und ihre Therapie. *Wien klin Wchnschr* 1910 xxxiii 557-559.
- SCHLATTER C. Subkutane Sehnenzerreissungen an den Fingern. *Deutsche Ztschr f Chir* 1907 8 vii 317-334.
- SCHRODER C. L. and LEWIS W. E. Rupture of the tendon of the extensor longus pollicis tendon transplantation. *Boston M & S J* 1903 cxlix 653.
- SONNATG E. Zur Behandlung der subluxierten Fingerstrecksehnenruptur am Endglied. *Märchen m d. Wchnschr* 1922 lxx 1333-1334.
- Idem. Zur Fingerstrecksehnenruptur am Endglied. *Zentralbl f Chir* 1926 lv 410.
- SPILLMEYER S. VON Beitrag zur Kenntnis der subluxierten Sehnenrupturen und Deckung von Sehnendefekten durch freie Sehnen transplantation. *Acta chirurg scand* 1921-22 lvi 177-209.
- WEIGOLD WALTER Ueber die Spontanrupturen der Fingersehnen. *Beitr z klin Chir* 1914 xcvi 310-338.
- WIRTHENAU VON Festra zur Trommelmehrmann. *Deutsche med aerztl Ztschr* 1889 xxvii 554.

## AN OPERATION FOR TUBERCULOSIS OF THE EPIDIDYMIS

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**E**PIDIDYMECTOMY for tuberculosis of the epididymis has not been an entirely satisfactory procedure. It has been found particularly unsatisfactory when done in the presence of sinuses. The operation as usually performed has in a great many instances been followed by breaking down of the wound by sinus formation and not uncommonly by loss of the testicle. These unsatisfactory results have led to illogical conclusions as to the proper method of dealing with this disease. Basing one's judgment upon the poor outcome from surgical treatment it has been recommended that tuberculosis of the epididymis be let entirely alone. It has been recommended that treatment be limited to the opening of abscesses when they occur irrespective of the fact that this leaves a persistent draining

sinus. In extreme cases as a result of this indecisive method of treatment it has not uncommonly been necessary to do a complete castration. Now, it is evident that a man is better off without tuberculosis of the epididymis than he is with it but he may be better off with it than to have his condition made worse by surgery.

The technique which I wish to describe has for its object the clean removal of the epididymis and sinuses and the securing of primary healing.

The stages of this technique are as follows. All tuberculous sinuses are painted with pure carbolic acid after the scrotum has been cleaned up. Next the scrotum is seized as shown in Figure 1 and gentle pressure is made above the testicle. An elliptical incision is then made through the skin around the sinus. Now while the pressure above

THE REFLUX OF PANCREATIC AND DUODENAL SECRETIONS THROUGH A DRAINAGE TUBE IN THE COMMON BILE DUCT<sup>1</sup>

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THE reflux of pancreatic and duodenal secretions through a drainage tube in the common bile duct is a somewhat rare and distressing postoperative complication of operation on the biliary tract. Scant mention of such occurrence is found in the literature and difficulty is encountered in finding the cases because they have not been reported under titles that might give clues to their identity. That such cases do occur, however, seems beyond question. Codman (1908) reported a case in which following operation for stone in the common bile duct, with perforation and abscess, there was profuse drainage of sour smelling bile stained fluid both through and around the rubber tube in the duct. The skin and tissues in contact with the draining fluid were digested and the patient's general condition declined rapidly. Codman recognized the complication and reoperated closing the hole in the common bile duct. The patient recovered. Davis described two cases in which there was undoubtedly drainage of pancreatic and duodenal secretions from a tube in the common bile duct. Judd observed several such cases before the T tube came into use but none since. During the last 2 years we have observed this phenomenon in 4 cases. They are reported herewith.

**Case 1.** The patient, a Sioux Indian, aged 48 years, came to the clinic October 17, 1921, complaining of recurring attacks of epigastric colic with jaundice. Twelve months and 9 months previous to admission he had had severe right upper abdominal colic like pains and had vomited morphine was required for relief. Each attack was followed by jaundice for a few days. During the few months prior to examination he had much upper epigastric discomfort and soreness with considerable gaseous indigestion but no colic. He had known he had diabetes mellitus and he had been on dietary treatment.

The serum bilirubin was 5.2 milligrams for each 100 cubic centimeters and the Van den Bergh reaction was direct. There was considerable tenderness under the right costal margin. The blood sugar was normal and the urine was free from sugar. All other laboratory tests were negative.

At operation November 1 the right upper quadrant of the abdomen was a mass of edematous indistinguishable structures. There was a large stone about 2.5 centimeters in diameter which could be felt in the common bile duct. This was removed by opening the common bile duct directly over the stone. The stone was crumbly of the type

usually found in the common bile duct and was necessarily removed in fragments. After removal of the stone the duct was thoroughly washed out with a solution of sodium chloride. The diameter of the duct was about 2 centimeters and the finger could be easily passed up to the hepatic duct and down to the sphincter of Oddi which could be felt to be dilated abnormally. A No. 20 catheter was sutured into the duct with its end up in the hepatic duct. Further exploring was not done on account of the inflammatory condition of the area. The gall bladder was not seen. It was probably buried in the mass of edematous tissue. Three Penrose drains were left in the wound.

Drainage through the tubes was profuse. On the third day the drainage reached 1,670 cubic centimeters and on the fourth day 3,860 cubic centimeters. The fluid was thin and had a rancid odor and the wound became red and inflamed. The patient appeared very ill. There was some leakage around the tube and the margins of the wound began to slough. The profuse drainage continued to be between 1,000 and 2,300 cubic centimeters daily until the tenth day when the tube was removed. After this there was drainage from the sinus for 48 hours then it gradually stopped and the stools were of normal color. Tests were not made for the presence of enzymes. Fluids were given freely by mouth and subcutaneously and glucose 10 per cent and sodium chloride 1 per cent was given intravenously. A constant suction apparatus was used in the sloughing wound to keep it dry. After the drainage stopped the patient's general condition improved rapidly. The wound healed slowly but was completely healed on the twentieth day after operation. The patient left the hospital on the thirtieth day free from jaundice and in good condition.

**CASE 2.** A woman, aged 62 years, came to the clinic November 20, 1923, complaining of recurring chills and fever, pain in the upper part of the abdomen and jaundice. Cholecystectomy had been performed elsewhere 10 months previously. It was reported that the gall bladder was full of mud bile but it did not contain stones. Recovery from the operation had been uneventful. In August 1923 pain had appeared in the upper part of the abdomen with chills and fever up to 102 degrees F. Recovery without jaundice took place in 1 week. October 23 there was a recurrence of the chills and fever with marked weakness and jaundice. These symptoms persisted until admission to the clinic November 20.

The patient was emaciated and deeply jaundiced. The serum bilirubin was 18 milligrams for each 100 cubic centimeters and the Van den Bergh reaction was direct. The coagulation time was 17 minutes. The hemoglobin was 60 per cent, erythrocytes numbered 3,700,000 and leucocytes 6,000. She was kept under observation in the hospital for several days. The serum bilirubin and coagulation time remained high and repeated duodenal drainage was negative for bile. Five cubic centimeters of 10 per cent calcium chloride was given intravenously for 3 days and 500 cubic centimeters of citrated blood was given on the day of operation.

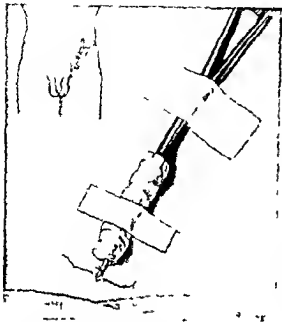


Fig 8 Vas pushed up through incision in groin. Clamp and vas wrapped in gauze and strapped to abdomen. Vas sutured to stab wound.

the testicle is still maintained with the hand very light elliptical cuts are made concentrically dividing bands of tissue directly down to the tunica vaginalis. These concentric cuts are kept close around the elliptical skin incision. It will be seen that if the cuts are kept close to the central portion of skin a thick scrotal wall will be maintained also the opening of any abscesses may be avoided as these can be seen and the tissues can then be cut lightly further out. As the cuts are made the testicle and epididymis begin to extrude from the scrotum at the same time one can easily see and ligate every bleeding point. This is important to insure a dry scrotal bed to which to return the testicle.

In this manner the testicle is extruded through the wound rather than delivered as is done when a so called high incision is made and trauma is avoided. The scrotum which has not been in any way contaminated is immediately wrapped with salt packs covered with a towel and kept absolutely surgically clean. Packs under the testicle complete the preparations for epididymectomy are complete. The tunica vaginalis is opened and the epididymis is separated from the testicle (Figs 3 and 4). The epididymis and testicle are both wrapped in warm salt packs and set aside (Fig 5). A clamp is pushed up along the vas

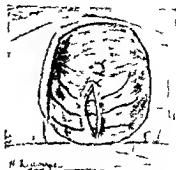


Fig 9 Closure of scrotum by through and through dermal suture without drainage.

until it corresponds with the external ring (Fig 6). A small nick is made over the tip of this clamp and another clamp is pushed down along the same path (Fig 7). This clamp is used for clamping off the vas (Fig 7). The vas is cut between two clamps thoroughly carbolyzed. The clamp and vas are then drawn upward to bring the vas out in the groin but at no time is the clamp removed from the vas nor is the vas ligated as all such attempts are likely to infect the wound.

A single stitch is passed through the nick (Fig 8). This stitch passes through the outmost covering of the vas. The clamp with the vas still fastened in it is wrapped in gauze and strapped to the abdomen (Fig 8). The scrotum is pulled down over the testicle and closed by interrupted dermal sutures. The wound is covered with colodion. The scrotum is supported with a binder.

In about 7 or 8 days the vas comes away at the level of the skin much as the umbilical cord shrivels and dies. In some instances the vas has seemed to keep up its blood supply and in these cases a ligature of catgut has been lightly tied around the vas at the skin level thereby causing it to slough away.

#### ADVANTAGES

The advantages of this operation over the so-called high incision procedure are

- 1 At no time is the scrotal bed soiled
  - 2 Extrusion of the testicle through the scrotum with the sinus formation attached avoids multiple incisions
  - 3 Trauma is avoided
  - 4 The entire thickness of the scrotum is preserved
  - 5 Bleeding points can be seen and taken up as concentric cuts are made
  - 6 The vas is not allowed to soil the wound
- The wound heals *per primam* in a large majority of instances.

# THE REFLUX OF PANCREATIC AND DUODENAL SECRETIONS THROUGH A DRAINAGE TUBE IN THE COMMON BILE DUCT<sup>1</sup>

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**CASE 1** The patient a Sioux Indian aged 48 years came to the clinic October 17, 1927, complaining of recurring attacks of epigastric colic with jaundice. Twelve months and 9 months previous to admission he had had severe right upper abdominal colic like pains and had vomited morphine was required for relief. Each attack was followed by jaundice for a few days. During the few months prior to examination he had much upper epigastric discomfort and soreness with considerable gaseous indigestion but no colic. He had known he had diabetes mellitus and he had been on dietary treatment.

The serum bilirubin was 5.2 milligrams for each 100 cubic centimeters and the Van den Bergh reaction was direct. There was considerable tenderness under the right costal margin. The blood sugar was normal and the urine was free from sugar. All other laboratory tests were negative.

At operation November 1, the right upper quadrant of the abdomen was a mass of edematous indistinguishable structures. There was a large stone about 2.5 centimeters in diameter which could be felt in the common bile duct. This was removed by opening the common bile duct directly over the stone. The stone was crumbly and the type

usually found in the common bile duct and was necessarily removed in fragments. After removal of the stone the duct was thoroughly washed out with a solution of sodium chloride. The diameter of the duct was about 2 centimeters and the finger could be easily passed up to the hepatic duct and down to the sphincter of Oddi which could be felt to be dilated abnormally. A No. 20 catheter was sutured into the duct with its end up in the hepatic duct. Further exploring was not done on account of the inflammatory condition of the area. The gall bladder was not seen. It was probably buried in the mass of edematous tissue. Three Penrose drains were left in the wound.

Drainage through the tubes was profuse. On the third day the drainage reached 1,670 cubic centimeters and on the fourth day 3,860 cubic centimeters. The fluid was thin and had a rancid odor and the wound became red and inflamed. The patient appeared very ill. There was some leakage around the tube and the margins of the wound began to slough. The profuse drainage continued to be between 1,000 and 2,500 cubic centimeters daily until the tenth day when the tube was removed. After this there was drainage from the sinus for 48 hours then it gradually stopped and the stools were of normal color. Tests were not made for the presence of enzymes. Fluids were given freely by mouth and subcutaneously and glucose 10 per cent and sodium chloride 1 per cent was given intravenously. A constant suction apparatus was used in the sloughing wound to keep it dry. After the drainage stopped the patient's general condition improved rapidly. The wound healed slowly but was completely healed on the twentieth day after operation. The patient left the hospital on the thirtieth day free from jaundice and in good condition.

**CASE 2** A woman aged 62 years came to the clinic November 20, 1928, complaining of recurring chills and fever pain in the upper part of the abdomen and jaundice. Cholecystectomy had been performed elsewhere in months previously. It was reported that the gall bladder was full of mud like but it did not contain stones. Recovery from the operation had been uneventful. In August 1928 pain had appeared in the upper part of the abdomen with chills and fever up to 102 degrees F. Recovery without jaundice took place in 1 week. October 25 there was a recurrence of the chills and fever with marked weakness and jaundice. These symptoms persisted until admission to the clinic November 20.

The patient was emaciated and deeply jaundiced. The serum bilirubin was 18 milligrams for each 100 cubic centimeters and the Van den Bergh reaction was direct. The coagulation time was 17 minutes. The hemoglobin was 60 per cent, erythrocytes numbered 3,100,000 and leucocytes 6,000. She was kept under observation in the hospital for several days. The serum bilirubin and coagulation time remained high and repeated duodenal drainage was negative for bile. Five cubic centimeters of 20 per cent calcium chloride was given intravenously for 3 days and 500 cubic centimeters of citrated blood was given on the day of operation.



At operation December 11 the common bile duct was found to be dilated to a diameter of approximately 2 centimeters. It was opened with the drainage of about 250 cubic centimeters of greenish bile. Scoops were introduced into the lower part of the duct and appeared to enter the duodenum through the ampulla. It was not possible to trace the duct upward to the liver. In view of the extreme jaundice and the patient's poor general condition it seemed advisable to attempt only drainage of the duct. Structure in the upper portion of the duct seemed the most likely cause for the obstruction but the accumulation of a large amount of bile in the lower part of the duct made it seem probable that the upper part of the duct was patent. A Mayo-Robson hepaticus drain was inserted in the common bile duct pointing downward toward the duodenum and the opening of the duct was stitched around it. There is a possibility that a stone was pushed into the duodenum. The abdomen was closed and two Penrose drains were left in the wound.

During the first few days there was an increasing amount of drainage of thin flocculent bile colored sour smelling liquid reaching 400 cubic centimeters on the sixth day. Methylene blue given by mouth came through the tube copiously. Analysis of the fluid showed the presence of considerable starch splitting enzyme. There was no leakage around the tube and the wound and skin were not irritated. Fluids were given liberally by mouth and intravenously in the form of physiological sodium chloride solution and the chemistry of the blood was kept within normal limits. By the tenth day the drainage began to diminish and there was bile in the stools. The Mayo-Robson tube was removed on the eighteenth day. The color of the stools was normal. The patient left the hospital on the twenty-ninth day in good general condition and with the wound healed. In a recent letter she reported that she has remained in good health.

**CASE 3.** A woman, aged 62 years, came to the clinic April 25, 1929 complaining of recurring attacks of colic in the right upper part of the abdomen of 3½ years' duration. Cholecystectomy had been done elsewhere in December, 1921, and stones were found in the gall bladder. The colic continued after operation, even more severe than before. Jaundice had not been present.

Examination disclosed mild general arteriosclerosis, the systolic blood pressure was 180 and the diastolic was 88. Tenderness was elicited in the right upper quadrant of the abdomen in the region of the old operative scar. Examinations of the urine and blood, including the Wassermann reaction on the blood, were negative. The serum bilirubin was 1.2 milligrams for each 100 cubic centimeters and the Van den Bergh reaction was indirect. The blood urea was 28 milligrams for each 100 cubic centimeters. Roentgenograms of the chest, stomach, kidneys, ureters and the urinary bladder were negative. Gastric analysis showed a total acidity of 60 and free hydrochloric acid of 40.

At operation April 30, 1929 a pouch about 1 centimeter in diameter was found in the stump of the cystic duct. The pouch was filled with small stones about 1 millimeter in diameter. The common bile duct was slightly enlarged. It was opened and explored with the finger tip down to the ampulla and stones were not encountered. The pouched stump of the cystic duct was dissected free and was removed. A medium sized T tube was sutured in place in the common bile duct. Examination of the duodenum, right kidney and pelvis was negative.

On the fourth postoperative day large amounts of foul smelling bile drained through the T tube 1½ cubic centimeters in 24 hours and on the succeeding day 1200 cubic centimeters. There was some leakage around the tube and the skin and margins of the wound became red

and irritated. Laboratory examination of this drained fluid showed the presence of considerable starch splitting enzyme. Methylene blue given by mouth appeared in the drainage material within a few minutes. Believing that we were dealing with a reflux of pancreatic and duodenal secretions, we began clamping the tube in an attempt to force the bile down into the duodenum and establish the normal direction of flow. Fluids were given freely by mouth and intravenously in the form of physiological sodium chloride solution and the chemistry of the blood stayed within normal limits. Bile appeared in the stools. The T tube was removed on the thirteenth day. There was profuse drainage from the fistula for 24 hours and then the fistula closed rapidly. It was completely closed on the seventeenth day. Dry radiant heat was applied to the wound and a soothing application was applied to the irritated skin. By the seventeenth day all signs of irritation had disappeared and the patient left the hospital on the eighteenth day in good general condition.

**CASE 4.** A man, aged 58 years, came to the clinic May 30, 1929 complaining of recurring attacks of severe pain in the upper part of the abdomen. Twenty-two years before he had had a severe attack of colic followed by jaundice. The colic recurred at infrequent intervals until operation was performed elsewhere in April, 1928. Cholecystostomy was done and stones were removed from the gall bladder. The wound drained for 3½ weeks and then closed. He was then well until 6 weeks before admission when he had a severe typical attack of gall tone colic and one week later he noticed dark urine and clay colored stools. During the 3 weeks prior to admission he had had 3 attacks of upper abdominal pain with chills and fever, the last one with jaundice 10 days before admission. Otherwise he had a rather typical history of peptic ulcer dating back 8 or 10 years with pain coming on 2 to 3 hours after meals and relieved by taking food or alkaline powder.

The patient was somewhat emaciated and 33 pounds under his usual weight. He was faintly jaundiced, the serum bilirubin was 4.3 milligrams for each 100 cubic centimeters and the Van den Bergh reaction was direct. Tenderness was elicited in the right upper part of the abdomen. The blood urea was 34 milligrams for each 100 cubic centimeters. Roentgenograms of the stomach and duodenum showed duodenal ulcer. All other laboratory examinations were negative.

At operation June 6 the gall bladder was found to be somewhat distended but did not contain stones. The common bile duct was opened and was explored with a scoop but stones were not found. The scoop passed readily through the ampulla into the duodenum. There was a large subacute duodenal ulcer on the anterior surface of the duodenum. The patient's general condition was not good so a rubber catheter was titched into the jejunum after the method of Witzel instead of gastro-enterostomy. This was brought out through a stab wound in the left rectus abdominis muscle. A Mayo-Robson hepaticus drain was left in the common bile duct and a dressed tube was left in the gall bladder.

During the first 4 days after operation there was profuse drainage of a rancid sour smelling thin flocculent bile colored fluid 115, 1530 and 1425 cubic centimeters respectively. Methylene blue given by mouth appeared copiously in the drainage material. Examination of the material showed the presence of a large amount of starch splitting enzyme. On the third day the blood urea was 67 and on the fourth day 74 milligrams for each 100 cubic centimeters and the patient appeared extremely ill. The margins of the wound were reddened and irritated from contact with the drainage material. On the fourth day the end of the Mayo-Robson drain was connected directly

with the jejunostomy tube so that the fluid draining from the common bile duct was poured directly back into the jejunum. The patient was given fluids in abundance including physiological sodium chloride solution intravenously 2,000 cubic centimeters daily. He seemed to improve but on the seventh day bronchopneumonia developed and he died on the eleventh day.

At necropsy the Mayo-Robson tube was found in place in the common bile duct. There was slight necrosis of tissue around the tube as it coursed over the duodenum. The common bile duct was 12 millimeters in diameter and there was a stone 6 by 8 millimeters impacted in the ampulla. The pancreatic duct entered the common bile duct 1 centimeter above the sphincter of Oddi and therefore proximal to the impacted stone. Other stones were not found in the ducts or gall bladder. A large subacute ulcer on the anterior surface of the duodenum and two smaller ulcers on the posterior wall were found. The lungs showed extensive bilateral bronchopneumonia.

#### SUMMARY AND COMMENTS

Certain features were common to all of the cases. There was a copious amount of drainage material, in each case amounting to more than 1,500 cubic centimeters in 24 hours. The draining fluid was thin flocculent and had a sour, rancid odor. Methylene blue given by mouth appeared promptly in the drainage material. Pancreatic enzymes were found in the drainage material in two of the cases (Cases 2 and 4). In one case (Case 3), in which there was leakage around the tube, there was considerable irritation and actual digestion of the skin and tissues around the wound such as is typical in pancreatic and duodenal fistulae. All of the patients appeared to be more seriously ill than is usual in disorders of the common bile duct. In Case 2 the reflux stopped after 4 or 5 days and the patient recovered uneventfully. In Case 3 it was possible to force the bile down through the duct by clamping the T tube gradually the reflux was overcome and recovery ensued. In Case 4, when it was found that reflux was present the Mayo-Robson tube was connected to the jejunostomy tube by means of a glass tube connector. Thus the bile and duodenal secretions that were draining from the tube in the common bile duct were poured directly back into the jejunum. This seemed to be an ideal arrangement under the circumstances. The patient began to improve but pneumonia set in and he died on the eleventh day from bilateral bronchopneumonia. In Case 1 the profuse drainage stopped soon after the drainage tube was removed and recovery followed.

The reason why there should be a reflux is not clear. Higgins and Mann working on healthy guinea pigs saw portions of test meals injected into the duodenum pass directly into the common bile duct. McArthur reported that reflux of barium from the duodenum coated a stone in the

common bile duct. Certainly in most cases of obstruction of the common bile duct such phenomena do not occur. Codman suggested that pressure of the root of the mesentery on the transverse portion of the duodenum causing back pressure was an etiological factor in his case. Abdominal distention with partial or complete ileus might be a contributing factor, especially when it occurs in cases in which the atonic duct and sphincter of Oddi are dilated. In all of the cases dilatation of the common bile duct was marked, and a sphincter was present through which a large sized scoop could be readily passed into the duodenum. This undoubtedly is a factor which tends to facilitate reflux but the presence of an additional factor seems necessary because of the many cases of dilated ducts in which such a phenomenon does not take place. It is possible that in cases in which the pancreatic duct empties into the common bile duct well up in the ampulla that a spasm below the opening or a stone impacted in the tip of the ampulla causes reflux of pancreatic secretion up the common bile duct and out of the drainage tube. Such a stone was found in Case 4 of the series.

The abnormal physiological changes in these cases are essentially the same as those in external duodenal fistula. Walters and Bollman emphasized the significance of the loss of fluids and chlorides in such cases and found that complete loss of pancreatic fluid is incompatible with life for more than a short period.

The early diagnosis of the complication is important. Drainage of more than 1,000 cubic centimeters of bile in 24 hours if it persists should arouse suspicion. If pancreatic and duodenal secretions are present the drainage material is thin, often flocculent, and has a sour rancid odor. If it comes in contact with the skin or tissues in the wound, there is hyperemia and later actual digestion of tissue. Methylene blue given by mouth should appear in considerable amounts in the drainage material a few minutes after its ingestion. Finally laboratory examination of the fluid will reveal the presence of digestive enzymes.

The treatment of such cases should be directed toward the prevention of the loss of these secretions and to combat the effect of the loss. It is essentially the same as for external duodenal fistula. Effort should be made to re-establish flow in the normal direction. Fluids should be given in abundance orally subcutaneously and intravenously to keep the chemistry of the blood within normal limits and to restore fluid and chemical loss. If under conservative and supportive treatment the condition does not promptly correct

itself, jejunostomy may be done. The draining fluid can then be injected into the jejunum with a syringe or by directly connecting the drainage tube of the common bile duct with the jejunostomy tube as was done in Case 4. I have successfully treated duodenal fistula by passing a tube by mouth into the proximal portion of the jejunum and feeding through the tube.

#### BIBLIOGRAPHY

1. COCHRAN, I. A. Chronic obstruction of the duodenum by the root of the mesentery. *Boston M & S J* 1908 *CLIN* 503-510

2. DAVIS, LINCOLN. Reflux of duodenal contents through the common bile duct. *New England J Med* 1920 *CC* 313-315
3. FINNORS, MAX. Duodenal perforation (fistula) treated by duodenal (jejunal) alimentations. *J Am M Ass* 1920 *LXXIV* 190-191
4. HERRICK, C. M. and MANN, F. C. Observations on the emptying of the gall bladder. *Am J Physiol* 1926 *LXXIII* 330-334
5. JUDS, F. S. Personal communication
6. McARTHUR, L. L. Repair of the common bile duct. *Tr Am Surg Ass* 1923 *XL* 1-18
7. WALTERS, WALTER and BOLLMAN, J. L. The toxicemia of duodenal fistula. Physiologic changes concerned in the production of its characteristic chemical reactions on the blood. *J Am M Ass* 1927 *LXXX* 1847-1853

## CARCINOMA OF THE THORACIC PORTION OF THE ESOPHAGUS

CARL IGERS, M.D., F.A.C.S., NEW YORK

**I**N spite of the stimulus given esophageal surgery by the successful removal of carcinoma of the thoracic portion of the esophagus in a few cases and in spite of the numerous and ingenious methods proposed, progress in this difficult field of surgery continues to be slow.

Sixteen years have passed since Torek reported his first successful case of resection of the thoracic portion of the esophagus for carcinoma. Hopes were raised at that time that one successful case would rapidly be followed by others. Unfortunately this has not proved true. In analyzing the reasons for this, it is at once apparent that no progress can be made until patients in better general condition and with the local lesion less advanced than is usually the case are referred to the surgeons.

The disease is insidious in its onset and the flexible esophagus is able to accommodate itself to the expansion of a new growth until actual obstruction occurs. At the time medical aid is sought it is often beyond the operable stage. The patients themselves are usually in poor general condition, they frequently have emphysema, myocarditis, arteriosclerosis or nephritis and are poor operative risks even if the local lesion is amenable to treatment.

In the report of my first successful case of esophagus resection in 1915 I mentioned the difficulties connected with esophageal surgery and called attention to the various methods employed to overcome them. It was pointed out that even in a so called favorable case the operation is a formidable one. It is no wonder that

surgeons hesitate to operate and that medical men are averse to referring their patients for a radical operation.

All important surgical procedures have taken time to develop and not until a so called standard method has been employed in a large series of cases has it been possible to reduce materially the mortality. It is so with esophageal surgery. It appears necessary to establish the operation of resection of the esophagus on a firm basis in order to gain the confidence of the medical profession as well as the public. For this reason every case should be reported; hence I present my second successful resection in detail.

Mrs. A. I., aged 55 years, came under my care January 23, 1919, with an established diagnosis of obstruction of the esophagus for the relief of which a gastrostomy had been done at another hospital in November, 1918.

She stated that the first symptoms were noted about 7 months before when in June, 1918, she experienced difficulty in swallowing. Food seemed to stick opposite the lower end of the sternum. After taking some water it would be washed down. About the same time she began to have a little sticking pain under the sternum at intervals. It was never severe and sometimes disappeared entirely. She paid no attention to the symptoms and did not inform her family of her condition until 3 months after the onset. A careful medical examination made at that time was followed by an X-ray examination which disclosed an esophageal obstruction (11, 12).

Of late the patient had complained a great deal of burning pain under the sternum, occasional pain in the back and loss of weight and strength. There was nothing in the past history which had any bearing on her present complaint except for nervousness and a disposition to worry she had been quite well.

The physical examination showed no evidence of organic disease. She was thin and looked as if she had lost weight.

Her weight was 228 $\frac{1}{4}$  pounds whereas her normal weight would have been 15 pounds. She was cheerful and rather anxious to undergo an operation for the relief of her symptoms. The gastrostomy functioned well and since its establishment she had been able to take fluids by mouth in moderation. There was considerable pain during deglutition.

A clinical diagnosis of carcinoma had been made the family of the patient had been thoroughly familiarized with the prognosis if the condition were left untreated and they had also been informed of the dangers of surgical interference. They desired operation if there were any prospect of removing the growth. The patient's general condition was quite satisfactory her heart action was good the lungs were clear and she had no kidney disease. The entire question hinged on operability of the lesion. There were no metastases to be felt and the X-ray examination of the chest showed no abnormal shadows. For the purpose of doing a biopsy to establish the diagnosis definitely and to help determine operability the patient was admitted to the Lenox Hill Hospital. An oesophagoscopy and biopsy were done by Dr. John D. Kerman who reported an ulcerating lesion beginning at about the level of the arch of the aorta. He felt that the tumor was operable. The pathological report by Dr. Frederick D. Hullock showed squamous cell epithelioma deeply infiltrating the muscular wall.

In spite of a carefully supervised diet the patient continued to lose weight. Nevertheless we considered her rather a better risk than the usual patient with oesophageal carcinoma and operation was decided on.

Operation was performed February 6, 1929, under gas oxygen-ether anesthesia administered by Dr. Charles Sanford using the Gwathmey apparatus. The patient was placed on her right side and an incision was made along the left seventh intercostal space for almost its entire length and was then carried upward posteriorly behind the angle of the ribs over the seventh, sixth and fifth ribs. The ribs were divided the intercostal vessels ligated and the thorax opened. A rib spreader was inserted and good exposure obtained. The lung was not adherent and was soft. It was allowed to collapse partly in order to explore the mediastinal region. One small hard nodule suggestive of a metastasis was felt in the hilus of the lung. An incision was made through the parietal pleura along the inner margin of the aorta and the mediastinum was entered. The oesophagus was exposed below and freed from its bed. By means of a tape it was drawn upward. The plexus of vagus fibers which enveloped it was pushed aside and the branches were saved as much as possible.

The dissection of the oesophagus was continued upward and a hard nodular tumor was encountered just below the arch of the aorta and extending upward behind it. With great care partly by blunt partly by sharp dissection the tumor mass was gradually mobilized. A large nodule projected toward the right side and involved the right pleura. After a portion of this parietal pleura had been sacrificed the tumor could be completely mobilized. Moist gauze packs were inserted into the mediastinum under the oesophagus and the latter was then doubly ligated with heavy silk well below the tumor and divided between the ligatures with a cautery. The lower stump was inverted by a silk pursestring suture into the stomach and two separate silk sutures were placed over the pursestring to reinforce it. The parietal pleura above the arch of the aorta was now split, the oesophagus was isolated there and after it had been freed downward to the tumor mass it could be drawn upward from behind the arch. It was temporarily wrapped in moist gauze. Attention was now given to the mediastinum below the arch. Oesophagus and tumor had been removed and the bed was clean. Unfortunately the



Fig. 1. Oesophageal obstruction beginning at the level of the arch of the aorta.

right pleura was open but on account of the moist packing over the opening there had been no serious change in the patient's condition. The right pleura could not be grasped in order to close it but the soft tissues of the mediastinum were allowed to fall together and over this the left parietal pleura was carefully closed by continuous plain catgut suture from the undersurface of the arch to the diaphragm. This effectively re-established two pleural cavities. The dissection of the oesophagus was now continued upward to the neck. The lung in the upper part of the chest was quite adherent and offered some obstacles which were overcome. A hard nodule could be felt in the apex but whether it was a metastasis or an old fibrous tuberculous nodule could not be determined. When the oesophagus was sufficiently mobilized the patient was turned on her back. An incision was now made in front of the sternocleidomastoid muscle at the lowest part of the neck and by blunt dissection aided by a finger extending upward through the thoracic wound the oesophagus was liberated and the entire organ with the tumor at its lower end brought out of the neck wound. It was wrapped in moist gauze and temporarily left there. The patient was now again turned on her side and the thorax wound re-opened wide. The parietal pleura above the arch of the aorta was sutured with continuous plain catgut to prevent leakage of air into the neck. The thorax looked clean and dry. Drainage was established by means of a stab wound through one of the lower posterior intercostal spaces. A  $\frac{1}{2}$  inch soft rubber tube was inserted and allowed to project  $\frac{1}{2}$  inches into the thorax. It was fastened to the chest wall by one suture. The lung was now fully inflated and the thoracic wound closed. Plain catgut was used to suture the intercostal

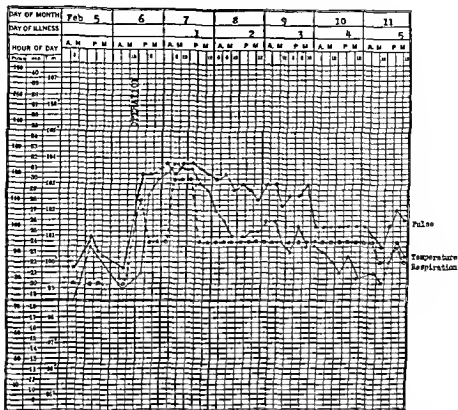


Fig Temperature chart first week after operation

tissues chromic catgut for the muscles of the chest wall and silk for the skin. The rib end approximated nicely without any difficulty. The wound was dressed and the patient turned on her back. Attention was now directed to the neck wound and the projecting esophagus. It was planned to remove the tumor with a safe margin of normal esophagus and then draw the esophageal stump through a subcutaneous tunnel and implant it on the upper thoracic wall. When I was ready to divide the esophagus I noticed a small tumor metastasis or implant in the muscular wall well above the main tumor. This necessitated division of the esophagus at a higher level than had been contemplated, leaving only a short stump which had to be implanted in the neck above the clavicle with some tension. It was first fixed to the neck muscles with a few catgut sutures to make retraction less likely and its open end was sutured to the skin with interrupted silk sutures. A small split tube drain was inserted next to the esophageal stump and a dry dressing was applied.

The patient stood the operation quite well. The complete operating time was 4 hours. The drainage tube with its end lower than the fluid level was connected with a drainage bottle in order to maintain closed drainage.

The patient reacted well after the operation. She was quite cyanotic for a while but by the following day the color was more normal. Respiration was a little difficult and jerky. There was a moderate amount of discharge from the esophageal stump and the dressing was therefore changed. Physical examination showed good resonance over both lungs with breath sounds heard all over. There

was drainage of about 60 cubic centimeters of sero-sanguineous fluid into the bottle during the first 4 hours.

The heart action was good and regular; the pulse was 120 and the temperature was 103.6 degrees. Her general appearance gave a good impression.

During the first 24 hours water was given by hypodermoclysis. Then administration of fluids through the gastrostomy tube was started and 4 ounces was given every 2 hours. An X-ray of the chest made the day after operation showed both lungs completely expanded with no fluid at either base. The rib fragments were in perfect position.

On the second day the temperature and pulse rate fell somewhat (Fig. 1) and the patient looked better. There was only 100 cubic centimeters of drainage during the second 4 hours.

On the third day no drainage from the chest was noticed. The drainage tube was therefore removed and the wound was covered with a dry dressing. The drain from the neck wound was likewise removed, as well as all the sutures from this wound, except those holding the esophagus stump.

On the seventh day the patient was allowed out of bed. She was given fluids by mouth which were at first expelled through the esophageal stump and caught in a pus basin in order to clear out the tract. Then a rubber tube was inserted into the stump and connected with the gastrostomy tube (Fig. 3).

Thereafter the patient was permitted to take fluids by mouth and swallow them the normal way to pass down through her rubber esophagus into the stomach or she

was fed through the gastrostomy tube as she desired. At first she was somewhat timid about swallowing through the tube but after a while she became quite adept at it and had the pleasure of tasting food of which she had been deprived for some time.

Swallowing through the tube was never as satisfactory in this case as it was in Torek's case or in my first case. There was frequently leakage along the tube, no doubt due to the shortness of the oesophageal stump. When the tube was put in too far it would impinge against the posterior pharyngeal wall or irritate the larynx and annoy the patient. The most troublesome condition however was regurgitation of food from the stomach all the way up through the rubber oesophagus into the throat. It took some time to learn to overcome this and the exact reason for it was never definitely determined. It seemed to be due to the fact that the stomach was constricted in its mid portion as the result of plication while performing the gastrostomy. The food entered only the distal or prepyloric region of the stomach and was regurgitated from there. Only if forcible pressure was made on the tube or vigorous swallowing efforts were made was the food distributed through the entire stomach. We were able to demonstrate this by means of a barium meal given through the gastrostomy tube.

Convalescence was uneventful aside from this and except for a great deal of pain at the site of the rib division. A superficial low grade infection developed which took considerable time to heal.

The patient was discharged March 31, 1929, well able to take care of herself. During the following months she continued to lose a little weight and she was never entirely free from pain which she referred chiefly to the upper part of her back and to the left shoulder region. On examination no metastases could be made out until May 28 when a deep-seated ill defined swelling was noted on the left side of the neck. When the patient was next seen a few weeks later a large mass had formed which occupied the region of and apparently involved the thyroid gland and the lymph nodes of the upper mediastinum and lower neck on the left side. It was quite fixed and surgically irremovable. There was no discharge from the oesophageal stump suggestive of ulceration of the mucosa and swallowing was not painful. Deep roentgen ray treatment was advised and is being continued at the present time. The mass has considerably shrunk in size. Roentgen ray examination of the lungs is negative for metastases and there are no symptoms or signs of disease below the diaphragm.

We were dealing with a patient 55 years of age who came to operation about 7 months after the onset of symptoms, which were then of an obstructive nature. Although the tumor was an epithelioma it was not of the flat variety but elevated and cauliflower like and therefore gave rise to difficulty with swallowing early in the disease. An X ray examination or an oesophagoscopy at that time would no doubt, have established this diagnosis and an operation would have given her a much better chance. As it was after months of symptoms with the associated loss of weight she was still a fairly good surgical risk, but from the standpoint of cancer surgery her chances were considerably diminished. There is reason to believe that she had metastases at the time of



Fig 3 Rubber oesophagus connecting oesophageal stump with gastrostomy

operation but that could not be definitely established. Pain was an outstanding symptom in her case and that is usually prognostically a bad sign as it indicates involvement of the surrounding tissue.

Of interest in this case was the extension of the tumor into the opposite pleura, requiring resection of a portion of that layer. It has been found that patients do not stand opening of both pleurae well but that an acute pneumothorax supervenes from which they do not recover. By being able to suture the left parietal pleura, both above and below the arch of the aorta, this danger was averted, and X rays taken on the day after operation showed full inflation of both lungs.

Although this case with its present metastatic tumor of the neck presages an unsatisfactory outcome, it nevertheless has to be counted as a successful surgical case. Whether the patient is permanently cured is not the point at the present time. We all know that in cancer of the oesophagus we have to deal with the same conditions that we encounter in cancer affecting other organs and that we are likely to have recurrences and metastases until patients are referred for surgical treat-

ment sufficiently early to improve the prognosis from a cancer standpoint. The most important thing at the present time is to establish the feasibility of successful operative removal. In planning the operation it must be the aim of the surgeon to have the patient reasonably comfortable after its performance. To operate with results which make life unbearable for the patient is not justified.

It is recognized that patients may be quite comfortable with a gastrostomy and in the opinion of the majority of surgeons this is the pro-

cedure of choice as soon as the patient reaches the stage of inability to swallow. The operation, however, is not curative but simply palliative. If, in addition to performing a gastrostomy, the tumor can be removed a great deal has been gained. If, however, in addition to removal of the tumor mastication and deglutition can be re-established, even through a rubber oesophagus outside the body as in Torek's case and my 2 cases, we are still nearer the ideal which is the direct internal connection between the resected oesophagus stump and the stomach.

## THE IMPLANTATION METHOD OF SKIN GRAFTING

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**I**n 1906 Wilhelm Braun of the Friedrichshain Hospital in Berlin described a new method of skin grafting. The method consisted in the implantation of small pieces of skin about 5 to 4 square millimeters in size directly into the granulations in such a manner that the implant just disappears from sight, much as one would deposit seed in the ground.

This is a very simple but effective means of covering a denuded area. An advantage of the method is that it can be employed in cases in which the commonly practised methods of skin grafting would fail. The only condition that must be fulfilled in employing the procedure is that granulation tissue must be present in the wound. The method, however, works well in the presence of infection and it is not necessary that the granulations be healthy. I have implanted these grafts with a satisfactory result into the granulations of a wound in which the wound edges were widely separated while faces from a colostomy were being discharged over the wound. I first employed the method in September 1908 in an aged man who developed a large pressure sore (Fig. 4) over one of the ischial tuberosities with considerable undermining of the skin following a thigh amputation for arteriosclerotic gangrene. As soon as granulations appeared in the wound these grafts were implanted and with surprising rapidity the defect became covered with epithelium.

We have employed the method now at the University of Minnesota Hospital in more than 60 cases. It is a method of transplantation of skin that can be used on ambulatory patients and on

a number of occasions we have used it in the outpatient department. In several of the instances in which we have employed these implantations, the Keverdin, the Davis, small deep or Thiersch grafts undoubtedly would have been satisfactory. The absolute indication for the method is in those cases in which other methods would fail, as in osteomyelitic cavities, chronic empyema cavities and decubitus ulcers with undermining of the skin. In a patient suffering from a paraplegia due to metastasis from carcinoma of the cervix uteri the method was employed in grafting a deep pressure ulcer that developed over the sacrum (Fig. 5). Shortly before the patient's death 7 weeks later a photograph (Fig. 6) showed that the defect was practically healed. The healing had taken place even though the patient lay on her back a good deal of the time and in spite of urinary and fecal incontinence.

### TECHNIQUE

The skin employed for grafting is obtained in the same manner as Thiersch skin grafts are cut from the anterior surface of the thigh (Fig. 1). Skin sterilization is accomplished by applying two coats of half strength tincture of iodine followed when dry by a saturated solution of sodium thiosulphate in 70 per cent alcohol. Anesthesia of the area from which the skin is to be removed is obtained with infiltration of 1 per cent

This is the most reliable procedure for the treatment of the patient. The patient is placed in the hospital and the skin is cut from the thigh. The skin is then sterilized with iodine and thiosulphate. The skin is then cut into small pieces and implanted into the wound. The patient is then discharged from the hospital.

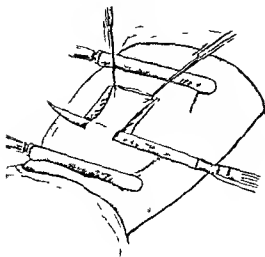
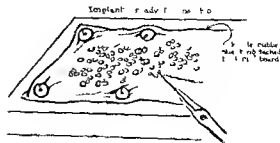


Fig. 1 Method of obtaining skin for implantation

procaine The surface into which the granulations are to be implanted is painted with 2 per cent mercurochrome. We have found that the implantation into the granulating surface can often be made without anaesthesia. When pain is complained of ethylene anaesthesia is given. The skin over the thigh is then held taut with two ordinary dinner plate knives and a thin sliver of skin about  $1\frac{1}{4}$  to 2 inches in width is cut with an easy sawing motion with a straight edge razor or a sharp amputating knife. A piece of skin about 3 inches in length will serve to cover a very large skin defect by this method. With a fine sharp scissors this Thiersch graft is then cut into many small pieces from about 2 to 4 square millimeters in size and the small segments of skin are placed on a towel that covers a sterile board. An ordinary small straight sewing needle is then grasped and on with a small Kelly hemostat such that the eye of the needle is at the free end. The small pieces of skin are then impaled (Fig. 2) with the blunt end of the needle and pushed obliquely into the granulation tissue until the graft just disappears from sight (Fig. 3). An ordinary tissue forceps is used to retain the graft while the needle is being withdrawn.

The entire granulating surface is seeded in this manner the grafts being placed about 1 to 1.5 centimeters apart. An unusually large defect can



Can be made of needle for use in grafting



Fig. 2 above The Thiersch graft is cut into small fragments about 2 square millimeters in diameter and these are impaled with the blunt end of an ordinary sewing needle. Fig. 3 Implanting the grafts.

be covered with a small amount of skin by this method. It apparently does not matter whether the skin side of the graft is up or down. These grafts really constitute a tissue culture *in vivo* and should have a good chance of survival.

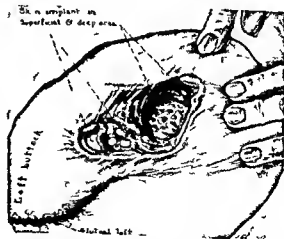


Fig. 4 A sketch made 10 days after implantation of grafts into a large undermined decubitus ulcer. The epithelial buds are sprouting and epithelium is being proliferated from the implants.

<sup>1</sup>In Felt Le skin a Cl. in C. eschwald skin is macerated and injected subcutaneously to the granulation with a needle and syringe. Attention of a method as to the implantation of skin employed by Alig. for more than 20 years should perhaps not be omitted. With a syringe Alig. places a fragment of skin about the size of the ordinary small deep graft.



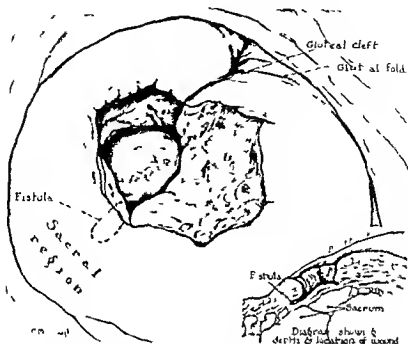


Fig. 5 Sketch made at the time of implantation of a large decubitus ulcer in a patient with paraplegia (A sinus tract is incorrectly labelled "istula" in the drawing)

Following the completion of the procedure the grafted area and the site from which the skin was removed are covered with vaseline gauze. No pressure need be applied to the surface where the skin has been implanted. After 3 or 4 days the vaseline gauze is removed from the grafted area.

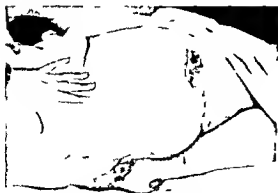


Fig. 6 Photograph of the same lesion a few days before the patient died (carcinoma of cervix with metastases). The ulcer that was implanted is practically healed. There is a newly formed smaller decubitus ulcer below.

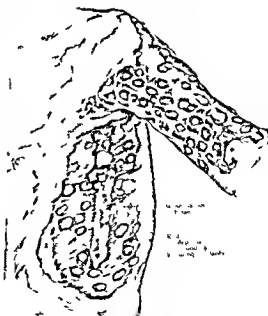


Fig. 7 Drawing made 14 days after implants were applied. An area of excavation is present about each implant. A single Thiersch graft was placed on the lower portion of the wound.



Fig. 8 left Photograph of same case taken a few days later

Fig. 9 Condition on discharge area practically healed but cosmetic result not very satisfactory. The skin is thin and with numerous large vessels in the regenerated epithelium



Fig. 10 left Condition on dismissal from the hospital, good cosmetic result in an extensive burn in which the implantation method of skin grafting was employed

Fig. 11 Lateral view of same patient a few small areas were uncovered at time of discharge. Subsequent examinations show the result to be very satisfactory

and similar strips are placed around the periphery of the wound and Dakin's solution is applied to the grafted surface sufficiently often to keep the discharge minimal. Bathing of the wound with Dakin's solution will not wash off the grafts.

After about 8 days the implants make their appearance as whitish necrotic areas. These rapidly increase in size and a thin layer of epithelium spreads out from these implants gradually covering the granulations. In some of the earlier cases grafted by this method a depressed area was frequently present in the granulations about the implant (Fig. 7). However since smaller grafts have been implanted and since Dakin's solution has been employed routinely to inhibit the excessive growth of granulations these saucer-like areas of excavation or depression around the implants have not been observed.

Carrel and Hartmann, during the period of the war, emphasized the importance of keeping wounds free from discharge to encourage healing. In their measurements of the rapidity of wound healing they found that when infection occurred in a wound the healing process stopped and the curve of wound healing flattened off directly.

It is frequently remarkable how quickly a granulating surface becomes covered with epithelium after the implants have made their appearance above the surface. The rapidity of healing is due, however in no small measure to the contraction of the healthy tissues about the granulating surface. Tracings made of the wound during varying stages of healing demonstrate this feature very well. This reduction in the actual size of the wound Carrel (3) described as granulous retraction. Unlike the small deep graft this implant fuses with the rest of the skin and does not preserve its identity. The ultimate appearance of the wound in which these implants have been used is not unlike that in which all the epithelization has been obtained from the periphery as in the ordinary healing of granulating wounds.

The cosmetic result in some extensive burns in which these implants were used has not been above criticism. In one such instance an unusually red thin skin with numerous visible vessels in

the regenerated epithelium obtained following the procedure (Fig. 9). In a few burns there has been a definite tendency toward keloid formation in the new epithelium. However the original severe nature of the injury to the tissues in these instances may have been as much or more responsible for the unsatisfactory result as the method employed in covering the defect. In several other burns in which the destruction has been less intense very satisfactory cosmetic results have been obtained (Fig. 10). A tendency to keloid formation in other types of wounds in which such implants have been made has not been observed. The percentage of takes by this method is high. Should a portion of the wound lag behind in becoming covered with epithelium this area may be reimplanted. Not infrequently one or two small granulating areas persist after the greater portion is entirely covered with epithelium. These areas are usually slow to heal. Keeping the granulations moistened with Dakin's solution during the period of wound healing and free from discharge will inhibit the heaping up of granulations and obviate the occurrence of isolated slow healing areas.

For the epithelization of excavated defects this simple method of skin grafting has no equal. The only requisite is that granulations be present, failure to obtain wound sterility is not a hindrance to the success of the procedure.

#### BIBLIOGRAPHY

1. ALCLAVE N. Réparation des pertes de substance cutanée par des semis dermo-épidermiques suivant un procédé dérivé de celui de Jacques Reverdin. Bull et mem Soc anat de Par 1900, LXXX 231. De la réparation des substances cutanées par des Semis Dermo Epidermiques. Presse méd 1911, Pt. 2 p 410.
2. BEHN, WILHELM. Zur Technik der Hautprophylaxe. Zentralbl f Chir 1920 No 32 p 1555. Leber Hautprophylaxen. Berl klin Wchnschr 1921 No 14 p 335.
3. CARREL ALEXIS. The treatment of wounds. A frt article. J Am M Ass 1910 11 2143.
4. CARREL ALEXIS and HARTMANN ALICE. Circumization of wounds. I. The relation between the size of a wound and the rate of its contraction. J Exper Med 1916 XXIV 49.
5. RECHRE Arch f klin Chir 1922 CXXI 232.

## RUPTURE OF THE URETHRA

## REPORT OF TWELVE CASES

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**D**URING recent years the number of cases of traumatic rupture of the urethra has apparently decreased. This is due probably to the increased number of safety devices and appliances in industrial pursuits. In past years numerous cases were seen in seaport cities where the injury occurred in sailors on the old sailing vessels. Nowadays the accident seems to occur almost exclusively in children who accidentally fall astride of some object or in men who are engaged in carpenter work, building construction, or some similar industrial occupation.

## TYPES OF RUPTURE OF THE URETHRA

There are 3 types of rupture of the urethra: rupture of the pendulous urethra, rupture of the bulbous urethra, and intra pelvic rupture of the urethra. Rupture of the pendulous urethra occurs but rarely, and none of the cases reported here is of this type. However during erection this condition may occur, or as Guyon states, the injury can occur during coitus.

By far the most common type of urethral injury is rupture of the bulbous urethra.

## RUPTURE OF THE BULBOUS URETHRA

*Symptoms and signs.* Patients who present themselves for examination immediately after rupture of the bulbous urethra has occurred usually complain of pain, hemorrhage from the meatus, difficulty or inability to void, tenderness and tumefaction.

The pain at first is sharp and steady in character and rarely is localized in the region of the rupture. Later it becomes more or less continuous in the perineum especially as the perineal hematoma develops. As this progresses and infection develops throbbing pain, fever, tenderness and chills may occur and all the usual toxic manifestations may appear.

Hemorrhage from the meatus always occurs. It is always well to remember that the degree of hemorrhage does not always indicate the extent of the rupture. Hemorrhage may be so profuse as to necessitate a transfusion, even in cases in which the urethra is only partially ruptured. In such cases the passing of a large catheter may control the bleeding while in others in which the

hemorrhage is not so profuse, surgical intervention may be required.

Inability to void is a frequent symptom immediately after the injury is sustained. This is due to the contraction of the lacerated urethra and spasm of the compressor urethral muscle. That this is the case is indicated by the fact that when the patient is placed under spinal anesthesia in preparation for operation, he may void. Later, the congestion, the hematoma and the infection are factors which produce the inability to void.

Due to the fact that reflex spasm of the compressor muscle prevents extravasation for a few hours and as a result of earlier diagnosis extensive extravasations are not as common now as in the past. When the rupture occurs above the bulbous urethra, extravasation into the cellular structures of the pelvis occurs immediately, thus rendering the condition more serious. Thus, an accurate diagnosis influences measurably the complications of the condition.

As tumefaction is primarily the effect of hemorrhage and extravasation, it will not be discussed at this time. Later, this tumefaction is influenced by urinary extravasation and superimposed infection. The extravasation which follows the fascial spaces has been discussed by Campbell.

Perineal hematoma, of course is usually present. Legueu states that the gravest ruptures are associated with the largest hematomata. From our experience, however, the size of the hematoma is not always a true index to the gravity of the condition. Occasionally the injury to the bulb of the urethra and its sheath may be marked, while the mucosa of the urethra is only slightly damaged. In one of our cases the urethra was almost completely ruptured, but only a small perineal hematoma was present.

*Diagnosis.* The diagnosis of rupture of the urethra is not always easy, and difficulty may be encountered in ascertaining the extent of the rupture. The symptoms and signs do not always indicate the degree of trauma. Although inability to void may be due to a reflex spasm of the compressor urethral muscle as the result of an injury, and clots may pass from a minor injury, usually the history of trauma of hemorrhage from the meatus and of a perineal hematoma associated

## ABSTRACTS OF HISTORIES OF CASES OF INJURIES OF THE URETHRA

No	Date	Injury	Cause of injury	Symptoms	Operation
1	7	Rupture of mucous membrane of urethra	Not stated	Considerable bleeding from urethra for week or so days thereafter began at night	Application of adrenalin and urethra packed with gauze within urethroscope for 3 weeks later recurrence
2	11-24-02	Ruptured urethra	While being driven to get a shoe he was struck from behind by nose of a bucket which hit him on left tuber (ischia and perineum)	Immediate desire to urinate but could not urinate left side of perineum slight abrasion considerable bruising over perineum penis edematous	Perineal section urethra separated about an inch from bulbomembranous portion. Suture end to end after ratgut bulbous part sewed deeper structures. Catheter left in place 2 days later later re-introduced 1 inch of tum it then remained not stated.
3	11-25-03	Ruptured urethra	While partially intoxicated slipped getting out of wagon with foot on hub and fell astride wheel	Difficult to urinate and painful micturition. Catheter passed at first but impossible 8 days later. Bladder distended extrusion of urine and ecchymosis in perineum	End-to-end anastomosis with fine catgut without going through mucous membrane
4 10 3-07	5-5-03	Complete rupture of urethra	While being let down from upper story by a rope slipped and fell about 10 feet landing against an iron rod	No micturition great pain all night attempt by physician to pass sound could not reach perineum but no more. Some blood clots and considerable urine passed later. Bladder greatly distended scrotum black and edematous. Ecchymosis	Scrotal and perineal incision suture end to end.
5	11-7-04	Ruptured	Fell astride carriage wheel	No micturition bled a few urethra started ecchymosis penis and scrotum edematous	Perineal section drainage tube inserted
6 age 11	6-10-07	Rupture of urethra (complete laceration)	Slid from hay loft and fell astride a barrel—3 day bed rest complete stasis	Not given	Perineal section blood clot evacuated bladder catheterized separated ends of urethra united with fine linen suture isoform drainage
7	1-24-11	Ruptured urethra	Fell astride buggy wheel 4 weeks before	Severe pain at perineum blood from meatus. In bed 2 weeks with blood applied to perineum. Well healed. No blood except just after accident. Increasing difficulty in urination	Found almost complete division of urethra. Plastic operation performed
8	5-28-11	Ruptured urethra	Not stated	Not stated	End-to-end anastomosis.
9	5-20-13	Ruptured urethra	Pile of lumber fell on patient lying on his back. Pelvis fractured in three places, and bladder ruptured. Bladder repaired drainage could be established through urethra but repeated attempts made	Not given	End-to-end anastomosis.
10	1-11-13	Ruptured urethra	Slid down from a scaffold a faucet which struck him a little to right of midline and about 2 inches in front of anus	Difficult to urinate very painful micturition impossible. Inflammatory reaction slight bleeding from penis.	Bladder catheterized with considerable difficulty. Good distal hemorrhage. No other treatment except catheterization.
11	10-5-13	Ruptured urethra (carcinoma)	Slipped and hurt scrotum 3 years before. Catheter inserted into bladder which by several months drained urine into rectum	No urine through penis at first. Cured, then urine through penis until 2 years ago. Urethra then closed and opening made through perineum. This opening closed a day ago and no urine is possible. Has had chills, burning, pain in some fever urine dark and burning.	Anastomosis of several rods of urethra to perineum, making new urethra. Much scar tissue found which proved to be carcinomatous.
12	5-25-13	Ruptured urethra			Urethra was found to be entirely divided the divided ends being sutured by a large hematoma. Plastic operation performed.

with inability to void indicates the presence of a rupture of the urethra. Catheterization under strictly aseptic conditions should be attempted. The soft rubber catheter is passed first and if it fails to pass into the bladder, then the coude catheter should be tried. By curving the tip of

the catheter it may follow the roof of the urethra which frequently remains intact.

In view of the injured devitalized and lacerated tissue together with the presence of a hematoma a fertile field awaits infection to avoid which every precaution should be exercised.

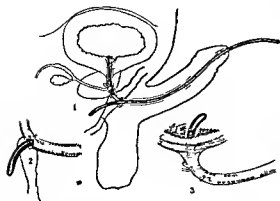


Fig 1 Rupture of the urethra Anastomosis of ruptured urethra over a catheter



Fig 2 Rupture of the urethra Penneal extravasation of urine

In one case, a urethroscopic examination demonstrated the lacerated urethra but usually the hemorrhage is so profuse that visualization of the urethra is difficult.

**Treatment** Controversy still exists as to the treatment of incomplete rupture of the urethra. Personally I am satisfied if a soft rubber catheter can be passed into the bladder.

Some French authors state that incomplete rupture is an etiological factor in the formation of strictures, but I am certain that adequate dilatation at a later date will overcome this obstacle.

Perineal section has been advised by Reginald Harrison and by others. However, if possible I believe it should be avoided. If infection supervenes, or we are unable to pass a catheter into the bladder, then perineal section is necessary.

The types of operations in complete rupture of the urethra are the following: (1) end to end anastomosis, (2) insertion of catheter, (3) Rutherford technique, (4) suture of roof of urethra.

In this series perineal section with end to end anastomosis was the procedure of preference in the cases which required surgical intervention.

The lacerated, devitalized tissues at the point of injury to the urethra are excised and the anastomosis is performed over a catheter, as in the illustration (Fig 1), the two posterior sutures being placed first and followed by the anterior sutures. The catheter is then strapped to the penis by adhesive to prevent its slipping out.

Heitz Boyers recommends removal of the catheter immediately after anastomosis, the urinary stream being diverted by a suprapubic cystostomy. In one case cystostomy with retrograde catheterization followed by incision and drainage in the areas showing extravasation, gave a good result.

In 1904 Rutherford described the sutureless method which seems satisfactory, especially in

cases in which infection and extravasation have occurred. He recommended suprapubic cystostomy followed by immediate perineal section. A catheter was then passed from the meatus into the bladder and no sutures were inserted, the perineal wound being packed open. He stated that when the patient was in the recumbent position, the cut ends of the urethra would come into close approximation over the catheter and union would take place, the catheter acting as a splint.

Rutherford Morrison's technique consists in suturing only the roof of the urethra, this being accomplished by interrupted catgut sutures. Then if a cystostomy is also performed, it is not necessary to insert a catheter. The perineal wound is packed open with gauze.

#### INTRAPELVIC RUPTURE OF THE URETHRA

Intrapelvic rupture of the urethra occurs less frequently than rupture of the bulbous urethra, and no case was encountered in this series. In such cases, the urethra is torn in association with crushing injuries of the pelvis. The seriousness of the condition can be comprehended when we realize the shock which is present in patients with a fractured pelvis, even without urethral injury. Thus this complication is serious. The rupture is usually at the apex of the prostate and tears the prostate from the membranous urethra.

**Symptoms** Symptoms of fracture of the pelvis are usually present and a grating sensation is elicited when pressure is applied to the iliac crests. Hemorrhage from the meatus also is a constant symptom and frequently is quite profuse.

Pain is usually very severe, and tenderness over bladder and hypochondrium is elicited. Rigidity over lower abdomen is present in some degree.

Bailey states that the extravasation usually is more prominent on one side or the other of the lower abdomen. Usually no tumefaction is present in the perineum.

**Diagnosis** The differential diagnosis between this condition and rupture of the bladder may be very difficult. However, if the bladder is distended and palpable, the rupture is below the vesical sphincter.

**Treatment** In the presence of this condition, immediate surgical intervention is necessary. Suprapubic cystotomy and drainage of the space of Retzius should be done as soon as possible. Due to rupture of the puboprostatic ligaments, the neck of the bladder and the prostate are displaced backward, as also by the pressure exerted by the extravasated urine in the space of Retzius. This displacement must be corrected as soon as possible before these parts become adherent to the adjacent tissue, so that their return to their normal position becomes possible. Moreover a permanent suprapubic fistula will result if this displacement is not corrected.

The patient's condition is such that 'he who hesitates is lost' and the operation must be performed as rapidly as possible. The perineal operation is performed 48 to 72 hours after the preliminary cystotomy.

The catheter is passed in a retrograde direction from the bladder to the perineum and is then passed out through the meatus. This catheter acts as a splint holding the bladder neck in normal position until the cut ends of the urethra unite. Fortunately, the membranous urethra in contrast to the bulbous urethra has but little tendency to stricture formation.

The complications which may accompany an intrapelvic rupture of the urethra are: traumatic stricture, extravasation of urine, and infection and gangrene.

Some degree of traumatic stricture usually ensues and it must be impressed upon the patient's mind that treatment must be continued after he leaves the hospital. The catheter is usually removed in 48 to 72 hours. After 10 to 16 days in instrumentation can be safely instituted. The further treatment is based upon urethroscopic study.

Extravasation follows the arrangement of definite anatomical structures, namely, the external and internal pelvic fasciae. Extravasation which occurs anterior to the triangular ligament spreads over a route limited by Colles fascia in the scrotum, perineum and penis and in the abdomen by Scarpa's fascia. Since these cases at the present time are seen and treated soon after the receipt of the injury, the extravasation is now usually

perineal and scrotal in type (Fig. 2). Formerly in cases seen later the extravasation had extended to the penis and lower abdomen. In cases in which the pendulous urethra is ruptured the penile extravasation is localized by Buck's fascia and rarely extends upward to the abdomen.

If the lesion occurs posterior to the triangular ligament, the extravasation usually involves the retroprostatic region and invades the upper inner aspect of thigh, the ischio-rectal fossa and buttocks.

If the lesion occurs between the layers of the triangular ligament, the extravasation may spread externally or toward the pelvis. Campbell reports 4 cases in which the extravasation extended to the ischio-rectal spaces. However in such cases the extravasation usually spreads externally.

When extravasation is due to an intrapelvic rupture of the urethra, it extends to the prevesical and perivesical regions, and as Bailey states, one side is usually more involved than the other.

Infection from the urine or that due to poor asepsis results in an extensive phlegmon which requires free incision of the involved regions. Albarran states that this phlegmon is due to anaerobic bacterial invasion and that the fluid is an inflammatory exudate. However as shown by Kidd, urea can usually be found in the fluid.

#### MORTALITY AND END-RESULTS

The mortality of rupture of the urethra is low if the case is seen immediately, but it is influenced by the time which elapses after the injury is received. With our present understanding of the condition it should be reduced to practically nil.

Stricture may result but under judicious, conscientious care this will respond to treatment. Better some degree of stricture than a dead patient.

#### BIBLIOGRAPHY

1. ALBARRAN. Quoted by Watson. F. S. and Cunningsham. J. H. Diseases of the Genito-Urinary System p. 91 Philadelphia 1908.
2. BAILEY. H. Brit. J. Surg. 1918 xv 370-384.
3. CAMPBELL. M. F. Peri urethral phlegmon. Surg. Gynec. & Obst. 1929 xlviii 332-389.
4. GUYON. F. Rev. gén. de clin. et de thérap. 1904 xviii 6.
5. HARRISON. R. Interstate M. J. 1906 xiii 723-726.
6. HEITZ BOYER. M. et al. Presse méd. 1918 xxvi 669-671. Ann. d. mal. d. org. génito-urin. 1909 ii 1581-1594.
7. KIDD. F. S. Common Diseases of the Male Urethra p. 124. London 1917.
8. LEGUEU. Rev. gén. de clin. et de thérap. 1923 xxxvii 691-696.
9. MORISON. R. Surgical Contributions vol. I p. 271 Bristol 1915.
10. RUTHERFORD. H. Lancet 1904 ii 751-753.

# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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MARCH 1930

### SPECULATIONS ON CONTROL OF INTESTINAL FUNCTION

THE romance of medicine lies in inductive philosophy, in which tomorrow is the great day. Yesterday furnishes the deductive philosophy, which acts as a compass to keep our directions true.

In mammals the testis is the primitive procreative organ, and because of its long heredity it is relatively free from disease, the ovary, secondary to the testis, is a more recent acquisition which has not yet achieved the same resistance. So, too, the sigmoid, a convenient storage organ but of more recent development, has not yet achieved the stability of the primitive small intestine. The right half of the large intestine is derived from the midgut, and in the embryo has the same type of epithelium as the small intestine and carries on an absorptive function. The sigmoid is derived from the hindgut and has relatively little absorptive function. By reverse peristalsis derivatives of the food end products are returned for further elaboration and absorption until the fecal stage is reached.

Certain recent investigations by Alvarez and his colleagues have shown the influence of food products on mass. Among the various types of food which form a mass, such common articles of diet as potatoes and milk form a relatively large mass, whereas red meats induce a large amount of bacterial action. Three fourths of the peoples of the world eat rice or carbohydrate and more or less fish for protein. Rice not only has a high caloric content, but also it liquefies and forms only a very small mass, such articles of diet as fish also form a small mass.

We are getting new light on the sympathetic nervous system, which acts as a brake on intestinal progress.

Speaking picturesquely, one notes various types of control over the vegetative functions, for example, the linking up of non-striated muscle with the nodal system and with the internal secretions so largely instrumental in carrying on gastro intestinal functions. These controls are shown in the occurrence of intestinal peristalsis once or twice in each minute and intestinal contractions eighteen or twenty times in each minute, the latter movements serving as a motor pump to propel venous blood in the portal system to the liver. All of these forms of stimulation are linked with the sympathetic nervous system and through the sympathetic ganglions with the central nervous system. Our knowledge of this interrelationship we owe to the fundamental work of Gaskell and Langley.

The work of Hunter and Royle stimulated fresh surgical interest in the sympathetic nervous system. In this field Adson and his associates have been able to relieve megacolon,



which so closely resembles the dilated œsophagus in cardiospasm, by removal of the lumbar sympathetic ganglions and their communicating branches. Learmonth points out that the operation effects its purpose probably by leaving the sacral sympathetic outflow, which is motor to the distal part of the colon, in sole control of this part of the bowel. Adson and his coworkers also have brought about marvelous relief in Raynaud's disease, in certain types of contraction of the blood vessels of the extremities leading to gangrene, and in certain types of arthritis, by removal of the appropriate sympathetic ganglions and their communicating branches.

W. J. Mayo

### TOTAL VERSUS SUBTOTAL ABDOMINAL HYSTERECTOMY

THE question whether a total or subtotal hysterectomy should be performed when hysterectomy is indicated is not settled. This assumption is correct since the issue is frequently discussed at medical meetings. There is no unity of opinion among general surgeons and gynecologists, some have discarded the one in favor of the other. During the past ten years many have advocated total hysterectomy for fibromyomata when removal of the uterus was indicated. The training and experience of gynecologists with this procedure are of course greater than of most surgeons, so that it is hardly fair to expect the occasional operator to adopt a technique with which he has had little experience.

There is a definite field for both procedures although I feel that total hysterectomy should be performed by experienced surgeons in most instances in which removal of the uterus is indicated, in which the cervix is definitely diseased, and when the patient is in good general

condition. On the other hand, if the cervix is small and there is no evidence of cystic disease or infection, the supravaginal or subtotal operation can be performed.

That the cervix is a source of infection and should be removed in all instances in which it is chronically diseased and in which hysterectomy also is indicated, has been shown by Rosenow, Moench, Benedict, and Nickel. Rosenow regards the cervix in the same light as the tonsils, as a focus of infection. Moench has found that the most conspicuous organism isolated from the cervix in cases of leucorrhœa is the streptococcus. Here, too, Benedict and his associates have shown the relationship between chronic cervical infection and lesions of the eye. Nickel recently produced hemorrhagic lesions around the trigone in bladders of dogs which had been injected with a culture from the cervical stump of a patient suffering from a Hunner's ulcer. Perhaps the most cogent reason for performing a total hysterectomy, whenever possible, is the fact that carcinoma is all too commonly seen in the cervical stump after the subtotal operation.

From statistics in most modern hospitals, carcinoma occurs in the cervical stump in about 1 per cent of the cases. Masson found that from 1910 to 1926 16 cases of carcinoma of the cervix were observed at The Mayo Clinic from 3 to 15 years after subtotal abdominal hysterectomy for benign lesions, and 13 cases in which it was not possible to determine whether or not malignancy had existed prior to the early operation. In about the same number of cases the cervix had been removed for troublesome leucorrhœa in cases in which subtotal hysterectomy had been performed previously.

The mortality for total abdominal hysterectomy should not be greater than for subtotal abdominal hysterectomy if the cervix

has been properly prepared. The vagina and cervix should be cleansed with soap and water and alcohol and then painted with three to five per cent iodine solution. If the cervix is soft and has a tendency to discharge a mucopurulent secretion, a small strip of iodine gauze should be placed in the cervical canal, or the cervix may be closed by means of three or four interrupted sutures.

At The Mayo Clinic during 1928 subtotal abdominal hysterectomy was performed 251 times in benign conditions with 2 hospital deaths (0.79 per cent), while total abdominal hysterectomy was performed 219 times with 1 hospital death (0.45 per cent). The death rate (5.88) for total hysterectomy in malignant conditions of the fundus is somewhat higher than in benign conditions. This increase in rate is not due to the type of operation but is attributed to the fact that many of the patients are usually senile, anæmic, and often cachectic. Death from either total or subtotal abdominal hysterectomy can be assigned to accidental causes. Pulmonary embolism is responsible for about 50 per cent of the deaths. This accident is being very materially reduced by administering thyroid extract, massage, passive movements of arms and legs, and tight abdominal binders after operation, as advised by Walters and Coffey.

Coming out the gland bearing area of the cervix or its destruction by the electric cautery following a subtotal abdominal hysterectomy has been offered as a substitute for total abdominal hysterectomy in the presence of a diseased cervix other than from cancer, and when hysterectomy is indicated as a safer procedure for those who have less ex-

perience with the latter operation. This will not safeguard the patient against future infection or carcinoma in the cervix because it is practically impossible to destroy all the glandular area in this manner.

The cervix and cervical canal should be inspected under direct vision preliminary to either a total or subtotal abdominal hysterectomy. Extensive infection often exists along the cervical canal near the internal os in an otherwise healthy appearing cervix. Early malignant growths may occur in the fundus and extend through the internal os to be overlooked through a subtotal hysterectomy, since carcinoma is associated in 5 per cent of fibromyomata.

Prolapse of the vaginal vault which is seen occasionally following either operation should not occur if the broad and round ligaments are accurately measured and sutured to the vaginal vault or the cervical stump. The approximations of these ligaments should be such that sufficient allowance has been made for contraction of the scar, so that sufficient mobility will follow without prolapse.

Subtotal abdominal hysterectomy should be performed in benign conditions when it is necessary to remove the greater part of the body of the uterus and when the cervix is in good general condition. Total abdominal hysterectomy is the best operation when any lesion other than carcinoma exists in the cervix and an abdominal hysterectomy is advisable, or when the history suggests the possibility of malignant change in the fibromyoma or an associated malignant condition in the fundus of the uterus.

VIRGIL S. COUNSELLER

# MASTER SURGEONS OF AMERICA

## DONALD MACLEAN

**D**ONALD Maclean was born at Seymour, Canada, December 4, 1839. His early education was obtained partly at Oliphant's School, Edinburgh, and partly at Coburg, Belleville and Queen's College, Canada. In 1858 he entered the medical department of the University of Edinburgh, becoming a licentiate of the Royal College of Surgeons in 1862.

Upon his return to the United States he became an assistant surgeon in the Army and served at various stations, among which were hospitals at St. Louis and Louisville.

In 1864, having returned to Canada, he was appointed professor of surgery in the Royal College of Physicians and Surgeons at Kingston, Ontario. In 1872 he accepted the position of lecturer and later professor of surgery in the medical department of the University of Michigan. He occupied this chair until the year 1889 when he resigned and entered private practice in Detroit, Michigan. Here he remained until his death, which occurred July 24, 1903.

Among the many honors bestowed upon him during his active life the following may be mentioned. In 1884 he was elected president of the Michigan State Medical Society. In 1894 he was president of the American Medical Association. He was elected to honorary membership in the Ohio State Medical Society and the New York State Medical Society. He was a member of the Royal College of Surgeons of Edinburgh, as well as a Fellow of the Royal College of Physicians.

Donald Maclean is best remembered as a great teacher. He inspired enthusiasm in his pupils and was sponsor for many great surgeons, some of whom have become famous. Of spare build, about five feet ten inches high, handsome and bold, he conducted his clinic in a dramatic manner and his kindly personality made him many friends in the medical profession.

J. WALTER VAUGHAN



DONALD MACLEAN  
1830-1903

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J WALTER VAUGHAN





# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN M.D. F.A.C.S. OMAHA, NEBRASKA

### THE WOUND SURGERY OF CÆSAR MAGATUS

**D**URING the closing years of the sixteenth century, the attention of the surgical profession centered upon the treatment of wounds. The old methods of treatment with boiling oil, the cautery and many forms of medicated dressings did not achieve the desired results and attempts were made by many surgeons to find improved methods which ranged from the weapon salve which Paracelsus tried to popularize to the puppy dog fat of Pare.

Possibly the weapon salve was more efficacious in treatment than Pare's fat for at least in its use the wound was not dressed daily or two or three times a day but one of the rules of technique was to dress the wound and then let it alone for 7 days meanwhile covering the weapon with the salve or powder and then disturbing it daily or oftener with a new dressing while it was kept warm and dry and away from dust and wind. This method of treatment had the advantage that while it could not possibly harm the implement which caused the wound it did serve to protect the wound against too much meddlesome surgical trauma.

Apparently some of the Roman surgeons recognized the harmfulness of frequently disturbing wounds for on one of his visits to Rome Cæsar Magatus learned of this method of treatment and was much struck with its benefits.

Magatus an Italian was born in 1579 in Scandiano. After studying at Bologna where he received his degree of doctor of philosophy and medicine he went to Rome to continue his medical studies. He probably had the opportunity at this time to observe the effects of the non interference method of treating wounds for he states in his work that the idea was not original with him but he had observed the technique in Rome and the results appealed to him. Returning to his home he at once obtained a great reputation for his surgical work and in 1617 was given the chair of surgery at the University of Ferrara then one of the great medical schools of the world. Four years after his appointment as professor he published his book which he called *Concerning an uncommon treatment of wounds or concerning the binding of wounds infrequently*. Magatus led a most active life for many years teaching and practicing. He was then taken with a severe illness which left him extremely weak and evidently thoroughly worn out for he renounced the world and

worldly things and sought peace for his remaining years by entering the mendicant order of Franciscan monks known as the Capuchins. His desire for peace and quietude was not to be granted, however for his reputation had become so great that frequent demands were made for his services. Evidently as his health returned so did his desire to get back into the harness for he obtained from the authorities of the order a special dispensation to practice in the principal cities of Italy and again took up work, remaining in practice until his death which occurred at Bologna in 1647 following an operation for the stone.

Magatus states on the title page of his book that there are two important questions that he intends to decide in the work. First, whether it is better to unloosen and care for wounds daily or whether several days should be allowed to intervene between dressings and, second whether the use of tents and sponges are necessary in the cure of wounds.

Both of these questions he decides. The first in favor of less frequent dressings and the latter in the negative. He begins by giving the fourteen reasons why daily dressing of wounds is said to be necessary. The following are examples of these reasons. By uncovering the wound the putrefaction is exposed to view—even gangrene may supervene if wounds are not dressed frequently—it is necessary to renew the medicaments daily and observe their effects—to give a daily prognosis—to remove causes of irritation—and finally it has always been done hence why change. In this final reason Magatus states that authors say

A method which brings about health is not to be changed has been stated by Hippocrates. So by this method which uncovers, wipes off and cares for wounds often the wounds are brought to excellent condition as experience shows therefore it should not be changed. Therefore a wound should be dressed daily. Magatus then goes on to combat the arguments for daily dressings and shows that the same reasons may be given for less frequent dressings. He then gives his reasons for discarding the ancient practice all logically stated and in contradiction to the final argument for frequent dressings and states

That method of cure under which wounds are healed more happily and quickly than under another is the most excellent and judicious and as experience has shown that under this new method wounds are healed more happily and quickly than under another, therefore this new method is the most excellent and judicious.



CAESARIS MAGATI  
SCANDIANENSIS.  
IN ALMO FERRARIENSI

Gymnasio publici Medicinæ Professionis.

DE RARA MEDICATIONE VVLNERVM,  
*scilicet De Vulncribus raro tractandis*

LIBRI DV O

IN QVIBVS NOVA TRADITVR METHODVS,  
*quæ saluissimè, ac citius quam alio quouis modo sanantur Vulnera*

Quæcumque præterea ad veram & perfectam curam nonem attingent, diligenter  
excitantur per multa q̃ explicantur Galeni, & Hippocratis loca eò spectantia.

HAEC AVTEM DVPLICI QVÆSTIONE

I. *Vtrum milia sit vulneta quædam soluta, ac prout ex amplius innotuit dictis*

II. *Vtrum curandorum, et p̃uallorum q̃ sitis Curatio Vulneta sit iustissima*

NOVVM ARGVMENTVM EST, A NVLLO HACTENVS  
*tractatum, sed pulcherrimum, & Vulneta tractandis maxime fructuosum.*

AD ILLVSTRISSIMOS VIROS

D ALEXANDRV M FLASCVM  
*Equitem Habitns Calitrauz, ac Sapientum Iudicem*

SAPIENTESQVE MAGISTRATVS

D MARCHIONEM GALEATIV M GVALENGVM.

D MARCHIONEM ALOYSIV M BEVILAQVIVM.

*Ferrariensis Gymnasij Moderatores*

*Cum triplici Index Capitum Quæstionum et Rerum omnium memorabilium  
Superiorum p̃mittis & Index*



ENETIIS, M DC XVI

Apud Ambrosium, & Bartholomæum De, Fratres

ciples of treatment of the various types of nephritis are outlined and the procedures available to combat uraemia oedema and high blood pressure associated with renal failure are described. A well selected list of references adds to the value of the book. It provides an admirable summary of our present knowledge of an inexhaustible subject.

WALTER H. NADLER

THE small volume by Dr H. Hyslop Thomson on *Tuberculosis Its Prevention and Home Treatment: a Guide for the Use of Patients* merits careful reading by those afflicted with pulmonary tuberculosis and by those medical men into whose practice cases of this type occur.

While in the main, nothing new is injected in the book that has not been written by other authors many of the chapters are so concise and so impressive that it makes the book worth while. His emphasis of the value of sanatorium treatment and the necessity for after care is so forceful that if every patient ready for discharge from an institution could read it and follow his advice breakdowns would be less frequent. His chapter on personal measures involving such questions as rest exercise occupation sleep marriage and likewise, is of the greatest importance.

A very full index completes what is, in my mind 96 pages of good thought and good advice in the field of tuberculosis.

MAX BIESENTHAL

A COMPLETE review of the subject of abdominal drainage is found in the book by Cadenat and Patel.<sup>2</sup> The first portion of the work is historical, then follow brief chapters on the physics of drainage and a brief resume of peritoneal physiology. The remainder is devoted to a discussion of indications and contra indications for drainage in abdominal and pelvic operations.

Most surgeons will agree with the authors in their viewpoint on drainage. They are quite conservative in the use of drainage but oddly enough, while willing to omit drainage in suppurative appendicitis they feel unsafe in closing the abdomen after cholecystectomy because of the uncertainty of ligatures and sutures in the biliary ducts.

J. R. BLCHENDER

THE history, etiology pathology, symptomatology and treatment of gonococcus infection of the hip joint is presented by Lamy,<sup>3</sup> one of the leading authorities of Paris. The illustrations of arthritis of the hip are excellent.

The various types of arthritis are given including polyarthritis monarthritis osteoarthritis and the type associated with spondylose rhizomelique and

the puerperal and infantile types described. Complications include dislocations and acetabular protrusion.

The medical and surgical treatment is discussed and the abstracts of 160 cases taken from the literature.

PHILIP LEWIN

TWO international authors wrote the book on *Orthopedic Surgery*.<sup>4</sup> Since the appearance of the first edition one of the authors (Lovett) died. Three additional names appear those of Allison Ober, and Platt, all of international reputation and acknowledged ability. The first edition was dominated by a military atmosphere, the second edition fortunately is not.

There are many changes from the first edition—some of omission, some additions and some rewriting. Many advances have been made since the first edition appeared. For this reason every chapter has been reviewed, especially the sections on stiffness of joints and operative treatment arthritis deformans, affections of adult bone anterior poliomyelitis obstetrical paralysis and lateral curvature of the spine.

Entirely new chapters have been added on subjects of affection of tendons muscles, and fascia peripheral nerve lesions, pyogenic affection of bone vascular lesions of extremities, amputations, and artificial limbs.

The operative side of orthopedic surgery is well presented. The subject of adhesions is well treated as it is one of the subjects closest to the heart of one of the authors (Jones).

The sequence of subjects treated differs from other textbooks and is a welcome change. This volume will continue to serve as a standard orthopedic text and reference book. The bibliography is helpful though incomplete. The work of the publisher is excellent.

This book should be of great value to the student to the interne to the general practitioner and to the orthopedic specialist. It confirms the fact that Jones is the master orthopedic teacher of the world.

If Lovett could see this edition he would be proud.

PHILIP LEWIN

IN our books there is such a dearth of useful information on diseases of the esophagus that Abel's monograph on *Esophageal Obstruction*<sup>5</sup> fills a void. The reviewer knows of no other single volume on the subject. Every angle is covered in a masterful and complete manner. No omissions could be discovered. Special praise should be given to the chapter on diverticula.

The following minor criticisms might be offered: (x) In the handling of cardiospasm the treatment

<sup>1</sup> TUBERCULOSIS ITS PREVENTION AND HOME TREATMENT. A GUIDE FOR THE USE OF PATIENTS. By H. Hyslop Thomson M.D. D.P.H. New York and London: Oxford University Press, 1948.

<sup>2</sup> LE DRAINAGE EN CHIRURGIE ABDOMINALE. By Dr. F. M. Cadenat and Dr. M. Patel. Paris: Gaston Douin et Cie, 1948.

<sup>3</sup> LA GONORRHOÉE. By Marthe Lamy. Paris: Gauchier Villars et Cie, 1949.

<sup>4</sup> ORTHOPEDIC SURGERY. By Sir Robert Jones Bart. A.B.E. C.B. Ch.M. (Liverpool) F.R.C.S. (England, Ireland & Edinburgh) F.A.C.S. (U.S.A.) and Robert W. Lovett M.D. F.A.C.S. 2d ed. New York: William Wood & Company, 1949.

<sup>5</sup> ESOPHAGEAL OBSTRUCTION. ITS PATHOLOGY, DIAGNOSIS AND TREATMENT. By A. Lawrence Abel M.S. (London) F.R.C.S. (Eng.) New York and London: Oxford University Press, 1949.

## REVIEWS OF NEW BOOKS

**T**HAT principles and methods of treatment which are practised by the present Master of Rotunda Hospital are described in *Twedy's Practical Obstetrics*<sup>1</sup>. The subject matter has been well arranged and the book is well printed. Many of the views expressed vary somewhat from the attitude and teaching in the United States. The author still recommends submammary hypodermoclysis. The disadvantage of breast complications arising from this procedure in the nursing mother has led many to substitute the axillary region for this purpose. The reviewer regrets that the author still recommends intra uterine douching.

Happily the author has included a short chapter on prenatal care.

This book is recommended chiefly to the practising physician and not the student since the details in the pathology treatment are glossed over rather hurriedly. F I CORNELL

**T**HE small book on *Diagnosis and Treatment of Deformities in Infancy and Early Childhood*<sup>2</sup> is intended to supplement the larger textbooks of orthopedics in a preparatory way its object being to stimulate general practitioners and those in charge of obstetrics and infant welfare clinics to be on the lookout for signs of early deformity in those who may come under their care. The subject matter is well chosen and is presented in good sequence. It deals largely and in a practical way with preventive treatment. The choice of illustrations and the execution of same are satisfactory. The operative side of the treatment of the conditions discussed is not given much attention.

This volume should be of value to the medical student, the interne and the general practitioner. PHILIP LEWIS

**O**NLY the treatment of injuries of the skeleton is dealt with in Forrester's *Traumatic Surgery*<sup>3</sup>. The treatment of the various phases of trauma to the soft tissues with the exception of a chapter on surgical and non surgical treatment of peripheral nerve injuries is not included. The book is beautifully illustrated and gives adequate description of the author's method of handling various fractures and dislocations, his experience being based on many years of practice in the field of industrial surgery with additional experience obtained in the British orthopedic service during the War.

<sup>1</sup>TWEDY'S PRACTICAL OBSTETRICS. Edited and largely rewritten by Bethel Vol. 1000. M.D. F.R.C.P. M.R.I.A. 6th ed. New York Oxford University Press 1929.

<sup>2</sup>DIAGNOSIS AND TREATMENT OF DEFORMITIES IN INFANCY AND EARLY CHILDHOOD. By M. F. Forrester B.Sc., M.A., M.D. (Lond.) With a Foreword by Sir Robert Jones Bart., K.B.E. C.B. F.R.C.S. New York and London Oxford Univ. Press 1929.

<sup>3</sup>OPERATIVE TRAUMATIC SURGERY WITH SPECIAL REFERENCE TO AFTERCARE AND PROGNOSIS. By C. R. G. Forrester M.D. F.R.C.S. New York Paul B Hoeber Inc 1929.

One of the novel features of this volume is the attempt made by the author to estimate the average length of disability from the various skeletal injuries which exemplifies his viewpoint as a practical industrial surgeon. He gives indications and suggests the time in the course of management for the various injuries when massage manipulation and other physical treatment should be instituted. His viewpoint in regard to operative treatment is in general conservative. He is inclined to use wires for securing apposition of fractured bones more frequently than the average American surgeon now uses them. He describes his technique for forceful manipulation of stiffened shoulders and apparently is inclined to follow the teaching of the British school. He also describes Morrison's technique for the injection of "bipp" in osteomyelitis and recommends the methods of treating this disease in vogue in the British army during the War. He recommends the use of the Steinmann nail almost to the exclusion of calipers.

This volume is a valuable addition to the library of the industrial surgeon. It gives in pertinent English one man's view of the surgical management of these injuries. HARRY E. MCCR

**T**HE book on *Nephritis*<sup>4</sup> is an amplification of the Goulstonian Lectures delivered before the Royal College of Physicians in the spring of 1918. Despite the brevity of the work the author succeeds in presenting a survey of nephritis that provides a basis for reflection of the problems concerned with the study of this inexhaustible subject. The results of recent investigations are incorporated and their significance indicated. The modern conception of the relation of uræmia, œdema and blood pressure to nephritis is outlined and the direction from which further aid in their explanation may be expected is indicated. Thus it is shown how the study of uræmia involves inquiry into broad biochemical principles how œdema is probably always a manifestation of damage to tissues outside the kidney and how high blood pressure is more often a cause than a result of nephritis.

The classification presented has been found by the author compatible both with existing clinical and pathological knowledge. It resembles in the main that of Volhard and Fahr. Nephritis is conceived to comprise (1) the nephroses (lipoid nephrosis, chemical nephropathies and amyloid disease), (2) glomerulo nephritis (acute diffuse chronic diffuse focal and embolic), (3) arteriosclerosis (pre-nephritic stage or essential hypertension later stage with cirrhosis of spleen and kidneys and renal failure the so called chronic interstitial nephritis the malignant renal sclerosis of Fahr). The prin

<sup>4</sup>NEPHRITIS ITS PROBLEMS AND TREATMENT. By T. Lind Bennett M.D. (Lond.) F.R.C.P. New York and London Oxford University Press 1929.

modern medicine could regret reading. In the last chapter, 'Fever Hospital Problems' is a discussion of many topics not usually found in a volume of this character.

Twelve important contagious diseases are described in detail yet in untiring completeness. There are 32 plates, 14 of which are in color. The excellence of these illustrations not only makes the book more attractive but adds to its value as well. Numerous fever charts and also some tables are included.

Possibly the only improvement in her *Infectious Diseases* which could be brought about Claude Rundle has accomplished in the revised third edition. This latest edition has simply been brought up to date by the incorporation of advances which have been made in medicine during the past ten years. In this respect measles and scarlet fever have received particular attention. About one fifth of the total (614) pages is devoted to typhoid under the name enteric fever.

The book in its present form is much more convenient to handle than when it appeared in the size of the original edition. It should be studied and used for reference by all those desiring clear dependable knowledge concerning contagious diseases. A H

THE volume written by Alfred Gosset<sup>1</sup> and associates presents much of interest. In the first chapter Gosset, chief of the clinic, sketches the history, the present organization, and the functioning of the surgical clinic and the anti cancer center of the Salpêtrière.

Chapter II likewise from his pen, is devoted to the description of the technique of the operation for the cure of cancer of the breast. It serves to emphasize the principles laid down by Halsted and by

Handley. Of special interest is the chapter on the combined radium and operative treatment of cervico uterine cancer. They have performed an extensive hysterectomy of the Wertheim type five or six weeks after exposure to radium. Of seventy four cases thus treated there were three fatalities. Thirty two consecutive Wertheim operations did not have a single death. Fifty five and five tenths per cent are alive and well more than three years after the operation. There are chapters dealing with general anesthesia, resection of the right colon for malignant tumor in two stages, strawberry gallbladder, chronic hemorrhagic proctitis, and others.

The book is richly illustrated.

G H

THE book by Hartmann on *Travaux de Chirurgie* consists of fifteen separate monographs on the surgery of the stomach and duodenum. A statistical study is presented of all cases operated upon during the period 1914 to 1918. The causes of all deaths are discussed. A careful clinicopathologic study of chronic peptic ulcer of the lesser curvature is presented. While apparently favoring gastric resection, Hartmann emphasizes that he had had good results with excision of the ulcer plus a simple gastroenterostomy. He is opposed to intervention for a severe hemorrhage from an ulcer. Carcinoma is thought to develop rarely from a chronic gastric ulcer. There is a valuable and timely contribution on the anomalies and chronic dilatation of the duodenum. Mesenteric compression and periduodenitis are discussed as the etiological factors. Indications and technique of duodenoduodenostomy are presented. Gastric resection with a posterior terminolateral anastomosis is carefully described and illustrated.

G H

TRAVAUX DE LA CLINIQUE CHIRURGICALE ET DU CENTRE ANTI CANCER DE LA SALPÊTRIÈRE. By A. Gosset. Second series. Paris: Masson et Cie 1927.

TRAVAUX DE CHIRURGIE. SEPTIÈME SÉRIE. CHIRURGIE DE L'ESTOMAC ET DU DUODÉNUM. By Henri Hartmann. Paris: Masson et Cie 1928.

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

HEMORRHOIDS. THE INJECTION TREATMENT AND PRELIMINARY ANT. By Lawrence Goldbacher M.D. Philadelphia: F. A. Davis Company, 1930.

CLINICAL OBSTETRICS. By Paul L. Harper Ph.D. M.D. & D. F.A.C.S. Philadelphia: F. A. Davis Company, 1930.

THE TREATMENT OF VARICOCELES AND OF THE LOWER EXTREMITIES BY INJECTIONS. By T. Henry Tietze-Barber M.D. New York: William Wood and Company, 1929.

RESEARCH AND MEDICAL PROGRESS AND OTHER ADDRESSES. By J. Shelton Horsley M.D. St. Louis: The C. V. Mosby Company, 1929.

SONNENBRANDE ZUR STRAHLENTHERAPIE. VOL. XII. ÜBER RÖNTGENSCHADEN UND SCHADEN DURCH RADIO-AKTIVE SUBSTANZEN. IHRE SYMPTOME, URSACHEN, VERMEIDUNG UND BEHANDLUNG. By Phil. Doz. Dr. Wilhelm Flaskamp. With a Foreword by Professor Dr. med. et phil. Herman Wintz. Berlin and Vienna: Urban & Schwarzenberg, 1930.

A TEXTBOOK OF THE PRACTICE OF MEDICINE INCLUDING SECTIONS ON DISEASES OF THE SKIN AND PSYCHOLOGICAL MEDICINE. By various authors. Edited by Frederick W. Price M.D. F.R.S. (Edin.). 3rd ed. New York and London: Oxford University Press, 1929.

MAMMALIAN PHYSIOLOGY. A COURSE OF PRACTICAL EXERCISES. By E. G. F. Liddell D.M. (Ox.) and Sir Charles Sherrington O.M. M.D. D.Sc. (Cantab.) F.R.S. London: Oxford University Press, 1929.

might have been given in a more explicit manner (2) The oesophagoscope has far less value than one is apt to gather from this treatise. The reviewer believes that the oesophagoscope, aside from its use in the removal of foreign bodies, has a very limited field.

This unique and practical monograph cannot be too highly praised. It should be in all medical libraries.

A. A. GOLDSMITH

**E**LEVEN lectures on gastro-intestinal problems given at St. Andrews during the winter of 1927 by prominent English physicians and surgeons are published in book form under the title *Gastro-Intestinal Diseases*.<sup>1</sup> The subjects are clinical and statistical as regards symptoms and results of treatment. They are usually the personal views of the speaker derived from his own clinic. They do not seem to be the formal presentation of research but are more in the nature of discussion of common problems giving personal opinions and deductions rather than scientific conclusions. As such the lectures are interesting, some seem a little old-fashioned, some are disappointing, but all are worth reading as giving the ideas of good men.

PAUL STARR

**A**n unusually good book has been written by Oscar Mercier on the diagnosis of urinary disease.<sup>2</sup> A short commendatory preface has been written by Professor Marion. The significance of chemical, microscopical and bacteriological findings of the urine are clearly discussed in detail. Urea nitrogen retention in the blood, Ambard's constant and the excretion of phenolsulphonephthalein are given as the most accurate methods of testing renal function. About one third of the treatise is given over to modern radiographic studies of the kidney, pelvis, ureter and bladder. The presentation of the value of lateral cystography is amply illustrated. The cystoscopic appearance of various lesions of the bladder and urethra is discussed in detail and each condition is clearly depicted in colored illustration. The book is a valuable contribution on the utilization of modern urologic methods of diagnosis and apparently is intended for the specialist rather than the general practitioner.

VINCENT J. O'CONNOR

**M**ODERN urologic diagnosis is dependent not only on cystoscopy but on ureteral catheterization, a study of renal function, roentgen ray examinations and pyelography. These subjects as well as operative cystoscopy are considered by Dr. Eugen Joseph, the author of *Lehrbuch der diagnostischen und operativen Cystoskopie*.<sup>3</sup> Because of its completeness the book is a novel departure.

<sup>1</sup>GASTRO-INTESTINAL DISEASES. LECTURES DELIVERED AT THE JAMES MACKENZIE INSTITUTE FOR CLINICAL RESEARCH, ST. ANDREWS, SCOTLAND, 1927. Edited by FR. JESSOP, D. M., and WATSON, M. A. WINTER, SCOTLAND. New York: Oxford University Press, 1928. 312 pp. P. R. C. S. (Edn.).

<sup>2</sup>NEPHROLOGICAL URINAIRE. By OSCAR MERCIER. Preface by G. MARION. Paris: Masson & Co., 1927.

<sup>3</sup>LEHRBUCH DER DIAGNOSTISCHEN UND OPERATIVEN CYSTOSKOPIE. By DR. EUGEN JOSEPH. Berlin: Julius Springer, 1929.

About one half of the book is devoted to the subject of cystoscopy, exposition. A point that is well taken and of such importance that it is rightly stressed by the author is the value of the history and a careful physical examination before the cystoscopy is done. The various types of cystoscopes and the technique involved in achieving the best results in cystoscopic examination as well as the various kinds of anesthesia are thoroughly discussed.

The different cystoscopic findings in the usual and the rare bladder lesions are given. The cystoscopic pictures and even such rare lesions as bilharzia and malacoplakia are well illustrated.

The value of roentgen ray examination and the subject of pyelography are carefully presented and well illustrated.

A subject that is ably treated by the author is operative cystoscopy, and because of the lucid manner in which it is handled an interesting and instructive chapter is added to the book.

The endovesical treatment of bladder tumors, the crushing of stones in the bladder under vision, the treatment of stones in the ureter and the technique of ureteral dilatation receive the attention which these subjects should always receive in a work on operative cystoscopy, but it is not often that the descriptions are as detailed as in this illuminating and profusely illustrated work.

**A**S the title page states, the book by Laurin<sup>4</sup> is a general study of the subject of artificial sterilization from the gynecological point of view. After a brief introduction and historical resume the author presents his *essai de justification* limited to discussion of the sociological and medico-legal argument. The indications for sterilization follow the well beaten path of those diseases of vital import: tuberculosis, the cardiopathies, renal affections, blood disorders, neuropsychosis and contracted pelvis. The argument is ably reinforced with statistics from recent clinical reports from French and German sources. In discussing eugenics as an indication, however, the author makes efficient use of reports from various states in our own country.

The second part comprises a review of methods of sterilization in which most of the better known procedures are set forth. In general the material made use of is well presented and set forth clearly, definitely and in an orderly manner. Particularly well formulated are the author's conclusions. A somewhat lengthy but not comprehensive bibliography is appended.

C. C.

**I**N his book on hemorrhoids,<sup>5</sup> Morley stresses the importance of having an expert treat hemorrhoids, whether the injection treatment is used or an operation is performed. Morley's comparison of the time required to effect a cure by injections with that

LA SÉRIÉLITÉ DE LA FEMME (ÉTUDE GÉNÉRALE). By DR. R. DE LAURIN. Paris: Imprimerie P. J. B. et Associés, 1929.

<sup>5</sup>HEMORRHOIDS: THEIR ETIOLOGY, PROPHYLAXIS AND TREATMENT BY MEANS OF INJECTION. By A. THURMORLEY, F.R.C.S. (Eng.). New York and London: Oxford University Press, 1929.

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## CHOLECYSTITIS A BACTERIOLOGIC AND EXPERIMENTAL STUDY OF THREE HUNDRED SURGICALLY RESECTED GALL BLADDERS<sup>1</sup>

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VARIABLE bacteria have been isolated by different investigators, from surgically resected gall bladders that have been the site of cholecystitis. That some of these bacteria are causative is shown by the fact that they produce lesions of the gall bladder when injected into experimental animals. This has been shown by various investigators (2, 4, 6, 7, 10, 11, 12). Some have been unable to duplicate Rosenow's results whereas others, such as Wilkie, have reproduced his results culturally as well as experimentally. Wilkie has isolated, as has Rosenow, the causative streptococcus in the biliary lymph node as well as in the wall of the gall bladder in a very high percentage of cases. He also has reproduced the lesions in rabbits in a striking manner, by injecting the streptococcus in different ways.

Recently at The Mayo Clinic we have made cultures from 300 consecutive gall bladders, using Rosenow's technique and in some instances Wilkie's modification. The cultures were made irrespective of the reasons for removal of the gall bladders and irrespective of the amount of pathological change visible. Twenty-three per cent of the patients were men, 77 per cent were women of whom 59 per cent were married. Many of the women gave a history of cholecystitis starting or recurring shortly after childbirth. Most of the patients

were more than 40 years of age, the youngest was 19 years of age, and the oldest 77 years. The majority (85 per cent) of all of these patients had potential foci of infection, such as pulpless teeth, chronic lacunar or follicular tonsillitis, prostatitis, endocervicitis, and sinusitis. The majority of those who returned to The Mayo Clinic later for re-examination still retained such foci even though there were consultant's notes on the charts advising their removal.

The cases were divided into four groups according to the symptoms (tabulation). Any patient who had a typical history of disease of the gall bladder was placed in group 1 or 2. If the condition was of 4 months' duration or less, the patient was placed in group 1, if of more than 4 months' duration, in group 2. Group 3 included those patients who had indistinct or vague symptoms not exactly typical of disease of the gall bladder. Group 4 included those patients in whom a stone in the cystic or common bile duct was the essential finding. According to this classification, there were 6 cases in group 4, in 3 of which cultures made from the gall bladder were sterile and in the other 3 of which the predominating organism was a gram-negative bacillus, in none was a streptococcus found. There were 116 patients in group 3, and cultures made from 75

DISEASES OF THE LYE. By Sir John Herbert Parsons C.B.E. D.Sc. F.R.C.S. F.R.S. 6th ed. New York: The Macmillan Company, 1930.

GALL BLADDER DISEASE. ROENTGEN INTERPRETATION AND DIAGNOSIS. By David S. Berlin B.S. M.D. St. Paul and Minneapolis: Bruce Publishing Company, 1929.

LEZIONI DI OSTETRICIA E DI CLINICA OSTETRICA VOL. III. LA PATOLOGIA DELLA GRAVIDANZA. Milano: Soc. An. Istituto Editoriale Scientifico, 1929.

BIOLOGIA Y PATOLOGIA DE LA MUJER. TRATADO DE OBSTETRICIA Y GINECOLOGIA PUBLICADO BAJO LA DIRECCION DE LOS DOCTORES. By Josef Halkan and Ludwig Seitz. Translated from the original by Joaquín Sanez Cimaldos in collaboration with Dr. D. Arcadio Sanchez López. Vol. II. Madrid.

ROENTGENUNTERSUCHUNGEN AM INNENRELIEF DES VERDAUUNGSKANALS. EIN BEITRAG ZUR KLINISCHEN KOENIGENDIAGNOSTIK INSBESONDERE VON ENTZÜNDUNG (ESCHWÜR UND KREBS). By Dr. Hans Heinrich Berg. Leipzig: Georg Thieme, 1930.

TEMPERANCE—OR IRREMINIABLE? The Hearst Temperance Contest Committee. Francis J. Tietz, Editor. New York: New York American Inc., 1930.

ELEMENTS OF SURGICAL DIAGNOSIS. By Sir Alfred Pearce Gould K.C.V.O. C.B.I. M.S. F.R.C.S. 7th ed. rev. By Inck Pearce Gould M.D. M.Ch. (Oxon.) F.R.C.S. (Eng.). New York: Paul B. Hoeber.

VORLESUNGEN ÜBER FUNKTIONELLE PATHOLOGIE UND THERAPIE DER NIERENKRANKHEITEN. By Dr. Baron Alexander Károlyi. Berlin: Julius Springer, 1929.

UROLOGIE PRATIQUE. By Dr. I. Bazy. Paris: Gauthier Villars et Cie, 1930.

OTOLOGIC SURGERY. By Samuel J. Kopetzky. M.D. F.A.C.S. 2nd ed. rev. New York: Paul B. Hoeber, 1929.

GLASGOW ROYAL MATERNITY AND WOMEN'S HOSPITAL. MEDICAL REPORT FOR THE YEAR 1928. Prepared by J. N. Cruickshank M.D. F.R.F.S. (Glas.) M.R.C.I. (Lond.). Glasgow: W. and L. Coghill, 1929.

HANDBUCH DER GYNÄKOLOGIE. Edited by W. Storckel. Vol. I. 1st half—Anatomie und topographische Anatomie.

Entwicklungsgeschichte und Bildungsfehler der weiblichen Genitalien. Munich: J. F. Bergmann, 1930.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. 54, 1929. Edited by Floyd E. Keene. M.D. St. Louis: The C. V. Mosby Company, 1930.

TONSIL SURGERY BASED ON A STUDY OF THE ANATOMY. By Robert H. Fowler. M.D. Philadelphia: F. A. Davis Company, 1930.

SURGERY OF THE LUNG AND PLEURA. By H. Morrison. D.M.S. M.A. M.D. M.Ch. (Cantab.) F.R.C.S. (Eng.). New York and London: Oxford University Press, 1930.

THE MECHANISM OF THE LARYNX. By V. E. Negus. M.S. (Lond.) F.R.C.S. (Eng.). With an Introduction by Sir Arthur Keith F.R.S. St. Louis: The C. V. Mosby Company, 1930.

DIE CHIRURGIE DER BRUSTORGANE. By Ferdinand Sauerbruch. 3d ed. Vol. I.—Die Erkrankungen der Lungen. With the Collaboration of H. Alexander H. Chaoul W. Felst. Part II.—Chirurgische Behandlung der Lungenentzündung, e. Geschwülste der Lungen, Echinothek der Lungen, Alveolomiose und andere Pilzkrankungen der Lungen, chirurgische Behandlung des Asthma Bronchiale, Syphilis der Lungen. Berlin: Julius Springer, 1930.

SYMPTOMS OF VISCERAL DISEASE. A STUDY OF THE VEGETATIVE NERVOUS SYSTEM IN ITS RELATIONSHIP TO CLINICAL MEDICINE. By Francis Marion Potten et al. M.D. LL.D. F.A.C.P. 4th ed. St. Louis: The C. V. Mosby Company, 1930.

A TEXT BOOK ON ORTHOPEDIC SURGERY. By Wilbur C. Campbell. M.D. F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1930.

TREATMENT IN GENERAL PRACTICE. By Harry Beckman. M.D. Philadelphia and London: W. B. Saunders Company, 1930.

THE HEALTH CARE OF THE BABY, etc. By Louis Fischer. M.D. 15th ed. rev. New York and London: Funk & Wagnalls Company, 1930.

DISEASES OF WOMEN. By Harry Sturgeon Crossen. M.D. F.A.C.S. and Robert James Crossen. M.D. 11th ed. rev. St. Louis: The C. V. Mosby Company, 1930.

made a culture from the remaining portion of the wall, consisting largely of the mucosa, after it had been washed in sterile solution of sodium chloride. It sometimes happened that cultures of the outer portion of the wall contained staphylococci alone or staphylococci mixed with streptococci, or bacilli, whereas the mucosal portion of the wall was sterile or contained the streptococci or bacilli without the staphylococci. This also was true of bacillus subtilis in a few instances. Consequently, we feel that sometimes at least, bacillus subtilis and staphylococcus albus were contaminants. In this respect our results correspond with those of Mestitz and Rittner, who examined smears and sections of the gall bladder immediately after surgical removal of the gall bladder and again after culturing the tissue. They found that in some cases in which the direct examination was negative, cultures showed staphylococci, or in cases in which the direct examination showed other organisms, after incubation the tissues showed the other organisms and staphylococci.

It is known that bile inhibits the growth of organisms, especially streptococci. In our experience it did not do so unless present in rather large amounts. This seems to be contrary to the experience of Wilkie. In only one instance did the outer portion of the wall yield a streptococcus when the inner portion remained sterile, and the growth of this streptococcus was not inhibited when 5 drops of the bile were added to 15 cubic centimeters of the culture medium before it was inoculated with 2 drops of a culture of the streptococcus in question. In tubes containing the macerated tissue of the gall bladder we have often added, with a Pasteur pipet, up to 10 drops of bile (later proved sterile) from the same gall bladder and have found that in the tubes which contained the bile the streptococcus and other organisms grew as well as in those to which bile had not been added. This was true no matter if the sterile bile came from gall bladders the walls of which contained streptococci, or were sterile. After we had determined this fact often enough to convince ourselves we discontinued culturing the wall piecemeal and simply washed the tissue in several changes of sterile solution of sodium chloride.

The number of our positive results in this series is not as high as that obtained several years previously with the same technique, nor as high as that obtained by Rosenow or by Wilkie. One of us (g) has reported previously that tethiothalein sodium N N R (iodeikon) has a marked bacteriostatic action for streptococci, and we thought that its extensive use for diagnostic purposes at The Mayo Clinic in the last 2 to 3 years might be responsible for the lowered incidence of positive cultures. Thus, we determined the time interval between the giving of the dye and the making of the cultures from the resected gall bladders in the cases with negative cultures on the one hand and in those with positive cultures on the other hand. Ninety nine, or approximately a third of the patients, did not receive dye. Most of these 99 cases, in which bacteria, especially streptococci, were found, were classified in group 1, in these cases rather acute conditions prevailed and a dye test was not advisable or necessary. In contrast, the majority of negative cultures in the 99 cases were from group 3, in which the symptoms were not typical of cholecystitis.

Of the 201 remaining patients who received the dye, the time interval in days between the giving of the dye and the making of the culture from the gall bladder was determined. This time interval was least in the group in which cultures remained sterile, and was 8.2 days. In the group in which a bacillus was isolated, the time interval was 8.4 days. In the group in which various forms of staphylococci and diphtheroid organisms were isolated, the time interval was 10.4 days, and in the group in which a streptococcus was isolated the average time interval was 11.2 days whereas in the group in which the streptococci were isolated in pure culture the average time interval was 12.8 days.

Rabbits were given intravenous injections of freshly isolated cultures of the various organisms, both with pure cultures and with mixed cultures, according to the technique described in previous publications. The animals usually were given injections on three successive days and were allowed to live from 1 to 6 weeks. During the experiments we discovered, as Cecil had discovered in experi-



of the gall bladders (65 per cent) were sterile, of the remaining 41 cultures, the predominant organisms were staphylococci and various bacilli. In only 8 of the 41 was there a green producing or indifferent streptococcus. There were 82 cultures of gall bladders of patients from group 2, 40 of which were sterile and 42 of which contained streptococci, staphylococci, or bacilli. Group 1 consisted of 96 cultures and only 32 per cent were sterile. Of the 64 positive cultures in group 1, 45 (70 per cent) contained streptococci, 35 of the 45 were pure cultures of streptococci. Thus, in group 1, in which one would expect good cultural results if the bacteria are of etiological significance 68 per cent of the cultures were positive, with streptococci predominating. In group 2, in which the condition had become chronic, 51 per cent of the cultures were positive. In group 3, in which most of the symptoms were vague and indistinct only 35 per cent of the cultures were positive. In group 4 in which obstruction to the ducts was the main finding, 50 per cent of the cultures contained a bacillus, but in no instance was a streptococcus isolated.

Altogether cultures were made from 300 gall bladders of which 150 (50 per cent) were sterile. Of the 150 cases in which the cultures were positive, in 66 (44 per cent), the predominant organism was a streptococcus, in 45 (30 per cent), a bacillus, and in 39 (26 per cent), a staphylococcus or other related cocci.

In this series of 300 gall bladders there were 65 "strawberry" gall bladders of which 46 (71 per cent) were sterile. From 9 gall bladders a streptococcus was isolated, from 7, a bacillus and from 3, staphylococcus albus. In most of the cases in which a positive culture was obtained from "strawberry" gall bladders there also was a complicating factor such as a stone in the cystic or common bile duct, or there was perihepatitis definite enough to be mentioned in the surgeon's report.

We also made cultures from numerous cystic lymph nodes. Cultures therefrom approximately paralleled those obtained from the walls of the gall bladders.

The streptococci usually produced distinct, green colonies on blood agar, often requiring a gradient of oxygen tension for growth. The

majority did not grow on a streaked blood agar plate until after at least one culture had been made in glucose brain broth. The bacilli were mainly gram negative bacilli, usually, they fermented dextrose, but the reactions of fermentation were variable in the other sugars. In three instances the reactions in sugars were those of typhoid bacilli. In a few instances, a gram positive, spore bearing bacillus was isolated. This was considered either a contaminant or a secondary invader, since it never produced any gross lesions in rabbits. According to the reactions in sugars, the streptococci most frequently isolated were streptococcus faecalis and streptococcus mitis. The other two types encountered to a lesser extent were streptococcus non haemolyticus 1 and 3. Neither the streptococci isolated from the bile or from the wall could be placed in any particular group since all the strains were isolated at times only from the wall, at other times only from the bile and at times from both the wall and the bile. Much stress has been placed recently on the relationship between streptococci and enterococci. As yet there is no definite agreement as to what constitutes an enterococcus. Some German authors (5) believe the enterococcus to be a variant of streptococcus viridans. Practically all of the strains that we have isolated are not enterococci according to the standards as summarized by Dible. They belong rather to the streptococcus viridans group called green producing streptococci by Rosenow to distinguish them from the streptococcus viridans lenta described first by Schottmueller.

Whenever extensive hemorrhagic cholecystitis or marked empyema of the gall bladder was encountered cultures therefrom almost invariably contained a gram negative bacillus, alone or in mixture with the streptococcus, and the gram negative bacillus usually fermented dextrose. According to cultural and experimental results staphylococcus albus was considered more often a coincidental than a causal factor, although in some instances the staphylococcus could not be considered a contaminant. Frequently, in making cultures from the wall of the gall bladder, we dissected off a piece of serosa and muscle and made a culture from it separately. We then, also,

made a culture from the remaining portion of the wall, consisting largely of the mucosa, after it had been washed in sterile solution of sodium chloride. It sometimes happened that cultures of the outer portion of the wall contained staphylococci alone or staphylococci mixed with streptococci, or bacilli, whereas the mucosal portion of the wall was sterile or contained the streptococci or bacilli without the staphylococci. This also was true of bacillus subtilis in a few instances. Consequently, we feel that sometimes at least, bacillus subtilis and staphylococcus albus were contaminants. In this respect our results correspond with those of Mestitz and Rüttner, who examined smears and sections of the gall bladder immediately after surgical removal of the gall bladder and again after culturing the tissue. They found that in some cases in which the direct examination was negative, cultures showed staphylococci, or in cases in which the direct examination showed other organisms, after incubation the tissues showed the other organisms and staphylococci.

It is known that bile inhibits the growth of organisms, especially streptococci. In our experience it did not do so unless present in rather large amounts. This seems to be contrary to the experience of Wilkie. In only one instance did the outer portion of the wall yield a streptococcus when the inner portion remained sterile, and the growth of this streptococcus was not inhibited when 5 drops of the bile were added to 15 cubic centimeters of the culture medium before it was inoculated with 2 drops of a culture of the streptococcus in question. In tubes containing the macerated tissue of the gall bladder we have often added, with a Pasteur pipet, up to 10 drops of bile (later proved sterile) from the same gall bladder and have found that in the tubes which contained the bile the streptococcus and other organisms grew as well as in those to which bile had not been added. This was true no matter if the sterile bile came from gall bladders the walls of which contained streptococci, or were sterile. After we had determined this fact often enough to convince ourselves, we discontinued culturing the wall piecemeal and simply washed the tissue in several changes of sterile solution of sodium chloride.

The number of our positive results in this series is not as high as that obtained several years previously with the same technique, nor as high as that obtained by Rosenow or by Wilkie. One of us (9) has reported previously that tetrathalein sodium NNR (Iodeikon) has a marked bacteriostatic action for streptococci, and we thought that its extensive use for diagnostic purposes at The Mayo Clinic in the last 2 to 3 years might be responsible for the lowered incidence of positive cultures. Thus, we determined the time interval between the giving of the dye and the making of the cultures from the resected gall bladders in the cases with negative cultures on the one hand and in those with positive cultures on the other hand. Ninety nine, or approximately a third of the patients, did not receive dye. Most of these 99 cases, in which bacteria especially streptococci, were found, were classified in group 1, in these cases rather acute conditions prevailed and a dye test was not advisable or necessary. In contrast, the majority of negative cultures in the 99 cases were from group 3, in which the symptoms were not typical of cholecystitis.

Of the 201 remaining patients who received the dye, the time interval in days between the giving of the dye and the making of the culture from the gall bladder was determined. This time interval was least in the group in which cultures remained sterile, and was 8.2 days. In the group in which a bacillus was isolated the time interval was 8.4 days. In the group in which various forms of staphylococci and diphtheroid organisms were isolated, the time interval was 10.4 days, and in the group in which a streptococcus was isolated, the average time interval was 11.2 days, whereas in the group in which the streptococci were isolated in pure culture the average time interval was 12.8 days.

Rabbits were given intravenous injections of freshly isolated cultures of the various organisms both with pure cultures and with mixed cultures, according to the technique described in previous publications. The animals usually were given injections on three successive days and were allowed to live from 1 to 6 weeks. During the experiments we discovered, as Cecil had discovered in experi-



Fig. 1. Empyema of the gall bladder of a rabbit 7 days after two intravenous injections with 4 and 5 cubic centimeters respectively of a 24 hour glucose brain broth culture of streptococci obtained from a surgically resected gall bladder.

ments on animals with arthritis that repeated injections even though small over a longer period of time, produced better results in many instances. In our experience pure cultures of staphylococci never produced cholecystitis, neither did cultures of so called diphtheroid organisms unless the diphtheroid organisms were streptococcus variants as evidenced by subcultures. In practically every culture of a gall bladder that had been the site of empyema and that had markedly thickened walls and in cultures of hemorrhagic, gangrenous gall bladders a gram negative bacillus was isolated sometimes in pure culture and often mixed with a streptococcus. When such freshly isolated cultures were injected into rabbits in small doses (bacilli of the colon group are quickly fatal to rabbits) they sometimes also tended to produce hemorrhagic gangrenous cholecystitis. In the rabbits that received injections of cultures of the streptococcus, focal lesions of the gall bladder often developed within 24 hours. However, in order to produce chronic indurated lesions, or cholelithiasis, 3 to 5 weeks were needed. In this respect, the colon bacillus differs from the streptococcus be-



Fig. 2. a Section of the wall of the gall bladder shown in Figure 1. There is swelling and necrosis of the cells of the tips of the villi (hematoxylin and eosin  $\times 1,300$ ). b streptococci in the necrotic tip of the villus (Gram Wever stain  $\times 1000$ ).

cause the colon bacillus usually produced mucopurulent bile with necrosis of the wall, in a shorter time.

Altogether 72 strains were injected into rabbits. Forty-one strains contained the streptococcus in large numbers and 28 (68 per cent) of these localized in the gall bladder of the rabbit. In contrast none of the strains of staphylococcus albus and only 5 of the 31 strains in which the streptococcus was absent or present only in very small numbers localized in the gall bladder of the rabbit. Seventy-eight rabbits were given injections of these 41 strains containing the streptococcus and in 35 (45 per cent) lesions of the gall bladder developed. In contrast 54 rabbits were given injections with the 31 other strains and in only 5 (9 per cent) lesions of the gall bladder developed. Altogether 137 rabbits were given injections of cultures obtained from the surgically resected gall bladders and in 40 (50 per cent) lesions of the gall bladder developed. The highest incidence of localization elsewhere in the body was in the joints (2 per cent). These percentages are comparatively low but it must be remembered that the majority of such experimental lesions are self healing. Consequently, in our endeavor to produce marked and more chronic evidence of cholecystitis as well as of cholelithiasis the animals were allowed to live for a long time and during this time the more



Fig 3 Hemorrhagic empyema of the gall bladder of a rabbit with adherent necrotic omentum 3 days after two intravenous injections of 5 and 6 cubic centimeters of a 24 hour culture of a mixture of streptococci and colon bacilli isolated from a surgically resected gall bladder

superficial and acute lesions healed. Notwithstanding this, including all the strains injected, some of which undoubtedly were contaminants the percentage of specific localization in the gall bladder was approximately ten times that obtained when specific strains isolated from patients with other diseases were employed.

The following results illustrate the various types of experimental lesions obtained.

A married woman aged 41 years with a history of cholecystitis of 19 years duration with recent exacerbations was operated on. A cholecystogram had not been made. At operation subacute cholecystitis was found implanted on chronic cholecystitis and there were multiple stones. Cultures made from the wall of the gall bladder and from the bile contained green producing streptococci. Cultures of the central portion of the stones were sterile.

Two rabbits were each given intravenous injections on 2 successive days of 4 and 5 cubic centimeters respectively of a glucose brain broth culture of this streptococcus. Six days later the rabbits were definitely ill and were dispatched. One rabbit had empyema of the gall bladder and slight perihepatitis. Sections of the wall of the gall bladder revealed numerous streptococci in places and coexisting coccidial infection of the gall bladder. Cultures of the bile contained numerous green producing streptococci whereas all other cultures were sterile.



Fig 4 a Section of the wall of the gall bladder shown in Figure 3. The wall is thickened and there is marked cellulitis with necrosis of the infiltrated tissue (hematoxylin and eosin  $\times 80$ ). b colon bacilli and streptococci found in the necrotic area shown in a (Gram Weigert stain  $\times 1000$ ).

There were no gross lesions in the other rabbit except those found in the gall bladder which was distended and the wall of which was edematous and thickened with irregular white confluent areas (Fig 1). Adherent to the mucosa were numerous tiny grayish white phlebotomist like bodies there were also a few of these bodies free in the bile which was watery and pale grayish green but which otherwise was grossly unchanged. Cultures of the blood spleen and joints were sterile. Those of the bile and wall of the gall bladder consisted of countless green producing streptococci.

Sections of the wall of the gall bladder (Fig 2 a) showed evidence of destruction of the raised portions of the mucosal folds with round cell infiltration many of the cells were leucocytes. Figure 2 b shows the streptococci in the necrotic areas shown in Figure 2 a.

The following results were obtained with a mixed culture of streptococci and bacillus coli.

A woman aged 61 years had been operated on previously for empyema and fistulas of the gall bladder at which time approximately two thirds of the gall bladder had been removed. She returned 3 years later with a recurrence of symptoms. At operation chronic catarrhal cholecystitis was found the walls of the gall bladder were thickened. Cultures made from wall of the resected gall bladder consisted of a mixture of green producing streptococci and bacillus coli.

Two rabbits were each given injections on 2 successive days of 5 and 6 cubic centimeters respectively of a glucose brain broth culture of this mixture. One of these rabbits died 63 days later. The body was emaciated but there were no gross changes except those found in the gall bladder which consisted of definite empyema with tiny stone like



Fig. 5. Stones in the gall bladder of a rabbit 44 days after two intravenous injections of 4 and 5 cubic centimeters respectively of a 24 hour glucose brain broth culture of streptococci and staphylococci obtained from a surgically resected gall bladder.

bodies free in the bile. The other rabbit was despatched 28 days after the first injection. Necropsy did not reveal gross lesions except that the gall bladder was distended and the walls were white and thickened (Fig. 3). The bile was replaced by a seropurulent fluid in which were many small white flakes. Direct smears of this material revealed gram negative bacilli and streptococci.

Sections of the wall showed it to be markedly thickened and infiltrated throughout with leucocytes; the mucosa was destroyed (Fig. 4 a). Figure 4 b shows the bacilli and streptococci scattered throughout the necrotic and seminecrotic tissues.

In order to suggest the probable relation of bacteria to formation of gall stones the following experiment is recorded.

Cultures were made from a surgically resected gall bladder in which subacute slightly hemorrhagic cholecystitis was implanted on chronic cholecystitis. There was one fairly large stone in the lumen of the gall bladder. A rabbit was given an intravenous injection on two successive days with 5 and 4 cubic centimeters respectively of a glucose brain broth culture of green producing streptococci and staphylococcus albus obtained from the wall of the surgically resected gall bladder. The rabbit remained apparently well and was despatched 43 days later. Necropsy revealed a distended gall bladder the wall of which was thickened throughout but was markedly thickened in places so as to form small sessile nodules 2 to 5 millimeters in their greatest diameter attached to the tips of the folds of the mucosa (Fig. 5). There were also two such nodules free in the



Fig. 6. a. Section of the wall of the gall bladder shown in Figure 5 at the juncture of the stone with the villus. Strands of viable connective tissue run for varying distances into the dark necrotic (stone) portion (hematoxylin and eosin  $\times 3,500$ ). b. streptococci in the living part of the villus. c. myriads of streptococci and staphylococci in the necrotic (stone) portion of the villus.

bile which was abnormally viscous and pale grayish green. Touching and cutting these nodules revealed them to be firm putty like masses containing some gritty or calcareous substance. Cultures of the bile and of portions of these 'stones' consisted mainly of green producing streptococci with staphylococcus albus.

Sections of the wall through such areas revealed it to be markedly thickened and oedematous. The mucosa was largely necrotic and was absent in places. The nodules were situated at the former site of the tips of the folds of the mucosa which they replaced. There was a sharp line of demarcation between the wall and the nodules. The nodules consisted of a homogeneous firm pink mass of eosin staining material containing myriads of bacteria. In the nodules near the attachment to the wall of the gall bladder were strands of apparently viable connective tissue that so far had resisted the action of the bacterial products. These connective tissue strands were continuous with the connective tissue of the wall of the gall bladder (Fig. 6 a). The streptococci and staphylococci were most numerous at the distal end of the nodules (Fig. 6 b) and they decreased in number as one approached the juncture of the nodule with the wall of the gall bladder. Streptococci also were found for some distance in the grossly unchanged tissue beneath the nodules (Fig. 6 c).

These experiments re-emphasize the fact that in certain forms of cholecystitis pathogenic organisms are present especially green producing streptococci and gram negative bacilli. On the contrary when the pathological diagnosis is 'strawberry gall bladder,' cultures from such tissues are usually sterile.

unless there are complicating factors such as hepatitis or stones in the ducts

By classifying the patients according to symptoms, we were better able to determine the relationship of bacteria to cholecystitis. For example, in a patient with a stone in the common bile duct, one would hardly expect to find pathogenic bacteria in the wall of the gall bladder unless it also was diseased or unless the bacteria had entered the gall bladder during stasis of its content. Likewise, one would not expect to find bacteria very frequently in gall bladders from patients in group 3 whose symptoms were not typical of cholecystitis. In some of the patients in group 3 gross evidence of cholecystitis could not be found at operation. Instead, there was found in some cases, hepatitis, duodenal ulcer, or an inflamed appendix, whereas in others various adhesions were found by which the symptoms could readily be explained. In such instances, without gross evidence of cholecystitis, one would not regularly expect to obtain pathogenic bacteria from the wall of the gall bladder.

Patients in group 2 had a rather chronic condition, and unless exacerbations occurred at various times, the chances for obtaining a positive culture here also were minimal. On the other hand, the majority of cultures from patients in group 1 should be positive if bacteria are associated with the cholecystitis and this seems to have been our experience. The majority of positive cultures containing streptococci especially were obtained from patients in group 1, whereas the majority of sterile cultures were obtained from patients in the other groups. We had hoped that there might prove to be a much longer interval of time between the giving of the dye and the cultures of the wall of the gall bladder in those cases in which the cultures were positive, in contrast to the cases with negative cultures. In accordance with our hopes there was a difference of 2 and 3 days between the cultures that were sterile and those that were positive for the cocci. Perhaps this was sufficient to account for the difference in the cultural results. If so it may help to explain why cultures of resected gall bladders made recently contained streptococci less often than the cultures obtained 4 or

# RESULTS OF BACTERIOLOGICAL INVESTIGATION OF SURGICALLY RESECTED GALL BLADDERS

Group	Symptoms of disease of the gall bladder	Cultures			Predominant organism isolated per cent		
		Number	Positive	Positive per cent	Streptococci	Bacilli	Staphylococci
1	Typical acute	95	64	68	70	16	14
2	Typical chronic	83	42	51	31	40	29
3	Vague	115	41	35	20	59	41
4	Stone in gall bladder or common bile duct	6	3	50		67	33
	Total	300	150	50	44	50	25

more years ago, such as Rosenow's. It may show, moreover, that the dye is endowed with therapeutic value.

There is another reason why Rosenow's results are higher than ours. His work was done years ago, when surgical measures were postponed until definite disease of the gall bladder was found. Then, too, he worked with selected cases in which gross pathological states of the gall bladder were marked, and he resected those gall bladders that were grossly unchanged.

That streptococci became localized in a gall bladder previously infected with coccidial cuculi illustrates that places of lowered resistance may be more susceptible to infection. It does not necessarily vitiate the factor of elective localization, because in many instances streptococci obtained from cases other than those of cholecystitis and injected into rabbits the gall bladders of which were infected with coccidial cuculi, did not localize in such previously infected gall bladders but produced lesions elsewhere.

Most of our experimental data in rabbits are in accordance with those of other similar studies. However, the production of cholecystitis with organisms other than streptococci, namely, gram negative bacilli, is of significance because it implies that the bacilli are not merely secondary invaders, a point originally mentioned by Rosenow. It also strengthens the idea of many that typhoid bacilli, apparently quiescent for a time in the gall bladder, may give rise to disease of

the gall bladder, and that, therefore, the gall bladder may act as a focus of infection. Our inability to produce lesions with pure cultures of staphylococci strengthens the idea that they are relatively unimportant.

At the time of the writing of this paper the report of Branch was noted. His results compare very closely with ours, even as regards the bile in the media. He found the following organisms in cultures and they are listed in the order of their frequency: bacilli, streptococci and staphylococci. Our results would place the streptococci first and the bacilli second. His conception of the bacterial content in various types of gall bladders is similar to ours and is aptly expressed in the following statement: "As for the relative frequency of the types of cholecystitis from which we recover organisms, the disconcerting consistency of positive cultures from the acute cases is only equalled by the persistent lack of growth from the chronic cases."

#### CONCLUSIONS

1. The majority of surgically resected gall bladders from patients with acute or subacute cholecystitis contain pathogenic bacteria, whereas the majority from patients who have chronic cholecystitis are sterile. The organisms isolated are according to their frequency, green producing streptococci, gram negative bacilli and staphylococci.

2. Cultures from "strawberry" gall bladders are usually sterile unless there is a complicating factor.

3. There is a longer time interval between the giving of the tetiothalein sodium NNR and the making of cultures from the gall bladders in those cases in which the gall bladders were found to be infected than in those that were sterile.

4. Streptococci isolated from grossly diseased gall bladders are of etiological signifi-

cance, since they tend to reproduce the *cholecystitis* and *cholelithiasis* in experimental rabbits when injected intravenously. The colon bacillus also may have a selective action for the gall bladder. It is usually found together with the streptococcus and is found frequently in relatively acute cases or in cases in which there are stones in the common or cystic duct. Staphylococci also are encountered, but we have found them to be non-pathogenic for the gall bladders of rabbits when injected in pure culture.

#### BIBLIOGRAPHY

1. BRANCH, C. F. A bacteriologic study of a group of diseased gall bladders. *New England J. Med.* 1929 cci 308-312.
2. BROWN, R. O. A study on the etiology of cholecystitis and its production by the injection of streptococci. *Arch. Int. Med.* 1919 cxix 183, 189.
3. DYER, J. H. Recent advances in bacteriology and the study of the infections. Philadelphia: P. Blakiston's Son and Company, 1920. 363 pp.
4. DRENNAN, JENNIE G. A bacteriologic study of the fluid contents of 100 gall bladders removed at operation. *Ann. Surg.* 1922 lxxvi 482-487.
5. GUNDEL, M. Die Enterokokken. *Centralbl. f. Bakteriol.* 1928 civ 384-392.
6. JAMESON, W. O. One hundred consecutive cholecystectomies. *Am. J. M. Sc.* 1925 clxx 181-183.
7. JORD, I. S., MENTZER, S. H. and PARKHILL, EDITH. A bacteriologic study of gall bladder removed at operation. *Am. J. M. Sc.* 1927 clxxix 16-23.
8. MESTRIZZ, W. and KUTNER, S. Zur Bakteriologie der Galle und der Gallenblase. *Arch. f. klin. Chir.* 1928 cliv 143-160.
9. NICKEL, A. C. The bacteriostatic and germicidal value of tetiothalein sodium NNR (Tetraiodophenolphthalein). *Proc. Staff Meetings Mayo Clinic* 1919 ix 178.
10. ROSENOW, F. C. Bacteriology of cholecystitis and its production by injection of streptococci. *J. Am. M. Ass.* 1914 lxxv 1835-1836.
11. Idem. The etiology of cholecystitis and gallstones and their production by the intravenous injection of bacteria. *J. Infect. Dis.* 1916 xix 527-536.
12. Idem. Focal infection and elective localization of bacteria in appendicitis, ulcer of stomach, cholecystitis and pancreatitis. *Surg. Gynec. & Obst.* 1921 xxxiii 10-26.
13. WILLIE, A. L. The bacteriology of cholecystitis: a clinical and experimental study. *Brit. J. Surg.* 1927-1928 xi 450-463.

## PSEUDOTUBERCULOUS SALPINGITIS

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THIS report is concerned with a foreign body type of inflammatory process in the oviduct which simulates tuberculosis histologically and which we believe has frequently been confused with tuberculosis of the oviduct.

Tuberculosis salpingitis, according to current conceptions, constitutes about 10 per cent of chronic adnexal disease. As gauged by statements in commonly recognized reference works on surgery, gynecology and pathology, it is usually regarded as the common form of genital tuberculosis in the female. Numerous authors state that it is benign in course in contrast to many forms of surgical tuberculosis and that following salpingectomy recovery is prompt and permanent in a large share of the cases.

Clinicians have naturally distinguished between cases in which tuberculosis is apparent elsewhere or widespread in the abdomen and those in which it is limited to the tubes. It is quite likely that the favorable course in cases of the latter type is largely responsible for the benign reputation of the disease.

Our attention was attracted to the disease by observation of 3 cases in current pathological material, of large, irregular, ring like masses of some foreign substance in sections of oviducts, which though much enlarged and patently diseased had some of the gross features of tuberculosis. The histological details in these cases showed clearly that the foreign material was not a residuum of previous caseation. They were generally enclosed in the bodies of large giant cells and there was usually associated a granulomatous reaction with extensive endothelial hyperplasia, tubercle like focal lesions and in some instances limited anemic necrosis. These interesting cases were long the subject of study and from the appearances of the rings of foreign substance it was suggested that they might be the shells of dead parasites possibly oxyuris vermicularis as the worms are reported to have been found in the tubes by several observers. Further

observations made this explanation of the nature of the substance appear incorrect but also prompted a critical review of the available cases classified as tuberculous salpingitis. Thirty four specimens containing this foreign material have been found in a total of 78 cases previously diagnosed as tuberculous salpingitis. A review of these specimens made apparent the fact that the foreign material was present in cases in which the lesions were least typically tuberculous and not discoverable in those cases in which there was more satisfactory histological evidence of tuberculosis.

## PATHOLOGY

*Gross pathology.* A review of the operation notes of the surgeons who had cared for the 78 patients showed that the existence of tuberculosis in the pelvis was suspected in only about one third of the cases on examination of the organs *in situ*. In about the same number of the cases pinhead size gray bodies were visible on the serous surfaces of the tubes and occasionally on the surfaces of contiguous viscera. Free fluid was present in the pelvis in about one sixth of the cases and in a few of these it was blood stained. The degree of enlargement of the tubes varied somewhat but they were not usually more than 1.5 to 2 centimeters in diameter. In several cases there was complicating secondary infection with puriform material in pockets between adhesions. Adhesions in the pelvis were usual but did not differ from the adhesions in chronic pelvic disease. They were usually formed by simple, not tuberculocaseous granulation tissue.

After removal the oviducts were enlarged and firm and tubercle like bodies were more commonly visible than at operation. On section they were gray or pinkish gray, sometimes with softened centers. In only one third of the cases was there gross caseation. With but 4 exceptions the tubes on section were of essentially normal shape and the increase in size was due mainly to increase in bulk of the mucous membrane. In a large number of the





Fig 1 Cross section of oviduct. The outlines of most of the mucous folds are still visible. The muscle coat is not thickened. The outlines of five or six small foreign body tubercles can just be made out at this magnification.

cases the site of the lumen was filled with a solid red core. The ovaries were not usually involved unless incorporated in the adhesions or inflammatory tissue about the tubes. In brief, the tubes on section usually had neither the appearances of a chronic suppurative process nor of frank caseation.

**Microscopic pathology.** In the 57 cases in which we considered that the morphological changes were deficient in important characteristics of tuberculous lesions including the 34 cases in which the collections of foreign material were found, the lesions were limited to the serous and mucous coats. The lesions of the serous coats were of two types: small tubercle-like nodules which formed in or about subserous lymphatics, and simple granulation tissue. Many of the small, gray bodies visible grossly were not tubercles but small collections of lymphoid cells, some even having germinal centers. Most of the subserous nodules were of foreign body tubercle type with a delicate reticulum and numerous small giant cells.

The increase in bulk of the mucous membrane was mainly due to the following basic lesions: focal collections of small giant cells; nodular and diffuse endothelial hyperplasia; fibroblastic reaction on the part of the sub

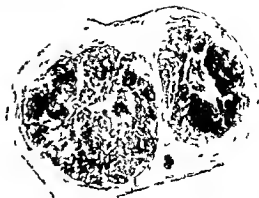


Fig 2 Cross section through an oviduct bent on itself. There is great increase in thickness of the mucous membrane. The outlines of some mucous folds are visible. There are no lesions in the muscle coat or subserous tissue.

epithelial stroma, and proliferative reaction in the epithelium.

The most frequent lesions were the small giant cell and endothelial nodules. They formed in the substance of the folds of mucous membrane either near the tips or down close to the internal muscle layers. While they produced some distortion of the mucous membrane, the general outlines of the mucous folds were generally fairly well retained. Particles of foreign material have been found in approximately half of these nodules.

Fibroblastic proliferation was extensive in some cases and either limited to the peripheral portions of nodular lesions or more diffuse. It was usually accompanied by endothelial proliferation and infiltration by lymphocytes.

Epithelial proliferation was extensive in some cases. If marked, the projections of the mucous membrane were broad and bulbous and covered with several layers of epithelium. There was a tendency to fusion of mucous folds with the formation of irregular epithelial lined canals or islets of atypical epithelium.

In some specimens there was limited central softening. This was usually associated with excessive mucous secretion, not only into the lumen and epithelium lined canals but also into the stroma of the mucous membrane. There was often scanty hemorrhage. As a consequence the lumina were often filled with a mixture of mucus, red corpuscle and epithelial cell debris.



Fig 3 Foreign body tubercles in distorted mucous folds. The giant cells contain crystalline material

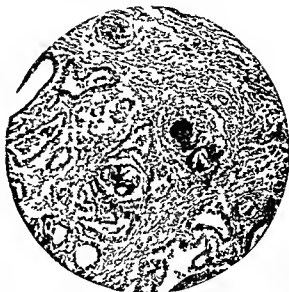


Fig 4 Two masses of foreign material in the bases of mucous folds. The foreign body tubercle at the left contains material in the form of fine particles

#### DIFFERENTIATION FROM TUBERCULOSIS

Through the courtesy of Dr Douglas Symmers, director of laboratories at Bellevue Hospital, we have had the opportunity of comparing the lesions in this surgical material with those in 10 autopsies in cases of disseminated tuberculosis in which the oviducts were involved. In the autopsy specimens the tubes were larger, they could not usually be separated from the tuberculous granulation tissue about them, caseation was extensive and usually extended into and through the muscle coats, and the tubercles on the surfaces were frequently confluent and caseous.

In the surgical cases none of the recent accessions have had typical tuberculous lesions and it therefore happens that the 14 cases in which there was reserve material for the application of stains for tubercle bacilli have been among those which we regard as pseudo-tuberculous. We have been unable to find tubercle bacilli in these and although failure to demonstrate tubercle bacilli has only negative value, it is pertinent to state that the lesions in these cases were not of such type as to suggest the presence of acid fast or other bacteria.

#### CLINICAL ASPECTS

An analysis of the clinical records of the total series of cases has been made, and there

appear to have been consequential differences in the clinical manifestations in the 21 cases in which the lesions are comparable to the lesions in the postmortem material reviewed and those in which we are inclined to believe the lesions are of foreign body type. The patients gave more evidence of being seriously ill. In 9 cases there was adequate evidence



Fig 5 Larger foreign body tubercles. Additional foreign substance visible with polarized light.



Fig 6 The foreign material in identical fields when examined with natural and polarized light

that there was tuberculosis in other organs. Three had definite signs of pulmonary tuberculosis. Two of these died within a year of tuberculosis. Two had extensive tuberculosis of the peritoneum and chronic obdurate sinuses persisted after operation. One patient had previously had a tuberculous kidney removed. She died a little more than a year after operation. In 3 cases there were definite lesions in the endometrium. In the 12 remaining cases in which the histological evidence of tuberculosis appeared sufficient the subsequent course of the disease is not satisfactorily known.

In the larger group in which we regard the histological evidence of tuberculosis as inconclusive or inadequate the presenting symptoms were decidedly less severe. They generally sought relief from a troublesome, but not alarming condition in the lower abdomen or pelvis. A presumptive diagnosis of genital tuberculosis was not made in any of the cases before operation, and in many cases the oviducts were not suspected of being the site of the trouble. The patients were, practically without exception, described as being well nourished and in fair to good general health. In several instances the diseased oviducts were discovered in the course of operations for

other gynecological conditions, as myomata uteri, ovarian cysts, uterine cancer, etc. Our information as to the eventual outcome of these cases is extremely meager. The immediate outcome was favorable with but one exception and in this case the patient died as the result of a surgical accident.

#### THE NATURE OF THE FOREIGN MATERIAL

After the group of cases in which the histological evidence of tuberculosis appears adequate is set aside, the tuberculous nature of the process in the remaining cases in which the foreign material was and was not found seems about equally uncertain. Since the foreign material appears to be responsible for the formation of the giant cells in many cases, considerable interest attaches to its nature.

When examined with natural light in stained preparations the substance most readily visible is that forming the irregular basic staining rings. These masses vary in size from 15 or 20 micra up to collections 60 to 80 micra in diameter. When hematoxylin has been briefly applied they may fail to stain and appear yellowish brown and slightly refractive. The material consistently gives a strongly positive von Kossa's reaction for calcium. They fail to react to this reagent

after brief treatment with weak acids, hydrochloric and nitric, or with acid salts, as copper acetate. They are fast to fat solvents, hot alcohol, ether, and xylol. After treatment with acids they are still stainable with ordinary histological dyes. Calcium sulphate crystals can be observed in formation microscopically when sulphuric acid is drawn under the cover slip.

Examination with polarized light gives additional information as to the amount and nature of the material. When observed with crossed Nicol prisms, great numbers of refractive, crystalloid clusters become visible in the centers of the basophilic masses and in the bodies of giant cells and endothelial nodules. All the material appears to be anisotropic. The individual crystals vary greatly in shape, many forms probably being abortive or imperfect crystal formations. The crystalline material is partially soluble in acids, forms calcium sulphate crystals and does not form gas bubbles when treated with hydrochloric acid. It does not reduce silver nitrate (von Kossa's reaction), probably on account of its relative insolubility.

Several unstained preparations were referred to Dr. Emil M. Chamot, professor of microscopic chemistry at Cornell University. He was able to extract the material from the preparations and to identify calcium phosphate and considerable amounts of ammonium magnesium phosphate. He suspected small amounts of calcium oxalate but was unable to assure himself on this point.

The more minute deposits in the nodules of endothelial hyperplasia are too small to permit of isolation and identification, but it appears likely that they are of similar composition and that the three forms in which the material is visible represent accretion stages.

Since it has taken many years for this considerable number of cases to accumulate fresh tissues for the application of fat stains have not been available. In several cases the cover glasses of frozen section preparations were soaked off and in this way small amounts of amorphous and crystalline fatty acids have been identified. This finding suggests that the ring formed bodies have their origin in deposition of fatty acids, saponification, and

calcium absorption. It is clear that further observations with fresh tissue are necessary in this connection.

#### THE SIGNIFICANCE OF THE FOREIGN MATERIAL

Our studies convince us that the peculiar lesions in the oviducts in nearly half of the cases are caused by the formation of foreign bodies in the tissues. We are certain, from reading the reports of the pathologists by whom the diagnoses of tuberculous salpingitis were made, that they were all greatly influenced in their decisions that the lesions were tuberculous by the presence of the giant cells. The view that this foreign substance is not a natural product of a tuberculous inflammatory process is supported by the fact that it is absent in the more typically tuberculous lesions. Calcium and magnesium phosphate are natural products of tissue and tissue juices but their presence in crystalline form in so many similar lesions requires explanation. Possibly in the course of an inflammatory reaction in the oviduct pathological metabolites, in the form of crystalline material, persist as foreign bodies and cause lesions simulating those of tuberculosis. This view certainly offers some explanation of the benign character of the disease.

#### SUMMARY

In a strict sense we have presented no conclusive evidence that the reaction in these cases is not a peculiar reaction to the tubercle bacillus. The absence of definite tuberculous granulation tissue, an obvious alternative cause for the formation of the giant cells, and finally, the lack of any clinical evidence of tuberculosis in other organs are cogent reasons in favor of our contention. It is clear that the problem requires further investigation. There are numerous instances in pathology in which it has been necessary to separate pseudotuberculosis from genuine tuberculosis as in the mammary gland, thyroid, ischio-rectal tissue, etc. At least, it is reasonable to insist that suspected cases of tuberculous salpingitis should be subjected to rigid bacteriological tests and that personal opinion as to the nature of histological lesions should be supported by animal inoculations.

## SOLITARY CYSTS OF THE KIDNEY

A REPORT OF SEVEN CASES AND OBSERVATIONS ON THE PATHOGENESIS OF THESE CYSTS<sup>1</sup>

ALLANDEK B. HILFER, M.D., F.A.C.S. SEATTLE, WASHINGTON

IN no other phase of renal pathology has there been so much fascinating speculation as to etiology, uncertainty as to pathogenesis, and lack of adequate classification as in the so called solitary cysts of the kidneys. The term "solitary" has been used to distinguish the large cysts of adult life from congenital polycystic kidneys and from the multiple small retention cysts of chronic nephritis. Yet the assumption that these cysts are an entity with a common origin on the basis of number and size alone does not seem justified from a review of the reported cases.

Many cysts have been recorded under the title of solitary that vary widely in their pathological features. Although they are defined as voluminous cysts, occurring singly in a kidney otherwise normal, a review of the cases which have appeared in the literature under this generic term shows that in many instances they were multiple and in some bilateral, that a large number were associated with definite and marked pathological conditions in the same kidney, and that many were indistinguishable from the larger nephritic cysts. Quite frequently hemorrhagic cysts have been included in the tabulation of solitary serous cysts.

From a study of the reported cases it is evident that this lack of conciseness is caused by the fact that large cysts in the kidney are not a distinct entity with a common histogenesis but that their direct etiology varies and because of this they may differ as to number, size, contents, sac wall, and associated renal pathology. It is my contention, however, that the mechanism of their production is essentially the same.

The same confusion exists in the classification of hemorrhagic cysts. Leopold suggested that they are a result of bleeding into a serous cyst. Some of them are. But there is a great difference between the thin walled cyst with serosanguinous contents, which evidently arise on this basis, and those whose thick walls

contain large amounts of fibrous tissue, atrophic renal parenchyma, at times remnants of tumor tissue, and an inner layer of organized blood clot arranged in superimposed lamellae of various ages. It has been suggested that they arise from hemorrhagic infarcts or encapsulated hematomata. Others contend that all these hemorrhagic cysts develop in neoplasms which have been destroyed in the growth of the cyst and the cells of which are left as remnants in the sac wall. Judd and Simon reported two cysts which they felt had their origin in aneurysms because of elastic tissue, intima, and endothelium in the wall. They feel that this is the most likely cause of hemorrhagic cysts.

So we find that there is a tendency for each author to describe the origin of this condition on the basis of his own particular case, being careful to exclude from his classification others with a definite etiology and with slight pathological differences, and losing sight of the fact that these cysts may not be a distinct entity with a common origin. The direct cause may vary and with it the pathological features, but the mechanism of the cyst formation is essentially the same.

The object of this paper is to report 7 cases of large solitary cysts of the kidney, 4 serous and 3 hemorrhagic, to present a review of the reported cases with particular reference to the etiology, and to describe the experimental reproduction of a solitary cyst which substantiated a new conception of their pathogenesis.

## REVIEW OF THE REPORTED CASES

I have been able to collect 249 cases, 12 of which were large serous cysts and 37 hemorrhagic (Table I). Seven personal cases, 4 serous and 3 hemorrhagic bring the total to 216 serous and 40 hemorrhagic. Cunningham's 19 cases of small solitary cysts associated with nephritis from the autopsy records of the Boston City and Long Island Hospitals are not included in this study.

<sup>1</sup> Read before the Clinical Society of Genito-Urinary Surgeons, San Francisco, July 15, 1929. Also Chairman's address, Symposium on Surgery of Kidneys and Bladder, Pan-Pacific Surgical Congress, Honolulu, T. H., August 25, 1929.



Fig 1 Roentgenogram of barium enema showing displacement of cecum and ascending colon by large cyst of right kidney (Case 1)



Fig 2 Pyelogram showing deformity produced by large cyst of right kidney (Case 1)

The difference in the number of collected cases of hemorrhagic cysts in this report and in that of Judd is caused partly by the fact that he excluded all cases associated with tumor and partly because quite a few cases of simple hemorrhagic cysts have not been reported under that title but have been included in tabulations of simple serous cysts.

The increasing number of case reports of solitary cysts indicates that this condition is not as rare as was formerly supposed. This

opinion is held by Branch (189), who says that although they are comparatively rare clinically, because many of them do not grow sufficiently large to cause symptoms, they are not a rarity to the pathologist and occur in 3 to 5 per cent of all autopsies.

A careful review of each case in which data was available has brought out the following pertinent facts with particular reference to etiology (Table II). The average age incidence for the serous was 45, for the hemorrhagic 48 years. Females were affected about twice as frequently as males.

In many instances a comprehensive clinical history was not given. When it was, it is of some significance that in quite a few the onset

TABLE I—REPORTS OF COLLECTED CASES OF SOLITARY CYSTS OF THE KIDNEY

	Collected	Personal	Total
<b>Serous cysts</b>			
Simon, 1906	51		57
Bretschner 1910		1	100
Harpster 1913	99		97
Mick in Williams, 1914	95	3	120
Lapierre 1915	117	3	124
Chalk M. Johnson 1916	119	5	137
E. Duesa 1917	135	3	130
Carson, 1918	117	4	151
Present report	2	4	216
<b>Hemorrhagic cysts</b>			
Souloux & Gouget 1915	7	1	3
Judd and Simon, 1917	11	1	15
Mick 1918	9	1	19
Present report	37	3	40
Personal Communication			

TABLE II—CLINICAL DATA

	Serous	Hemorrhagic	Total
Average age build on onset of symptoms followed shortly by appearance of a mass	45	48	
Average duration of symptoms in years	15	3	18
Rapid growth of cyst	18	8	26
Sex			
Females			161
Males			79

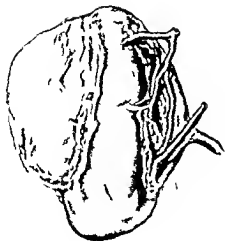


Fig. 3 Drawing of large thick-walled solitary cyst of right kidney (Case 1)

of symptoms was sudden and the growth of the cyst rapid. The average duration of symptoms was 2½ years. In 26 cases there was a rapid increase in the size of the cyst over a period of a few weeks to months.

In 30 instances the cysts were multiple and in 9 bilateral (Table III). The sac wall was invariably composed of fibrous connective tissue of different degrees of thickness in both the serous and the hemorrhagic.

In 23 cases, there were remnants of renal parenchyma, atrophic tubules and glomeruli in the wall not only at the cyst's point of contact with the kidney but in all portions of the sac. This indicates that in these instances the wall was made up of compressed renal parenchyma with a connective tissue substitution which was not complete. In addition, many of the hemorrhagic cysts had an inner layer of clot and fibrin.

TABLE III — PATHOLOGICAL DATA

	Serous	Hemor	Total
Multiple (21)		4	30
Bilateral	6	3	9
S. (wall)			
Remnants of renal parenchyma			
Atrophic tubules & glomeruli	16	9	5
Tumor—adenocarcinoma			
hypernephroma		10	
angelioma	4	5	0
Calcification			
Muscle and elastic fibers with remnant of			2
intima			

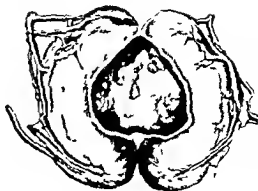


Fig. 4 Drawing of sagittal section of kidney (Case 2). There is a reversal of the kidney form. The internal border is convex and the external concave. Note the anomalous blood vessels and distortion of the pelvis.

In 10 of the hemorrhagic cases there were small irregular strands of tumor tissue scattered throughout the wall. These cases must not be confused with the ordinary cystic degeneration of tumors. When this occurs there is a predominantly solid tumor containing numerous large and small cyst-like cavities. Here we refer to the large monolocular cysts with no gross evidence of tumor except perhaps a small nodule at the deepest point of the cyst's contact with the kidney and remnants in the sac wall.

Two cases were reported in which the wall contained muscle fiber, elastic fibers and remnants of intima, from which it was concluded that the cysts arose from aneurysms. In 9 cases there was definite calcification.

TABLE IV — ASSOCIATED LESIONS IN THE SAME KIDNEY

Chr.	neg. biopsy—diffuse	t. v. l.	Serous	Hemor.	Total
t. v. l.			3		3
Tumor—hyperplasia		10		1	11
adenoma			1	1	2
Anomalous					
Hydronephrosis					
Dyst. pt.					9
Dyst. pt.					
Calcification					1
Anomalous arteries		1			1
Hydronephrosis			2		2
Pyonephrosis					1
Infarct			1		1
Leukemia					1
T. v. l.			1		1
Possibly from—benign renal t.				2	2
			04	15	83

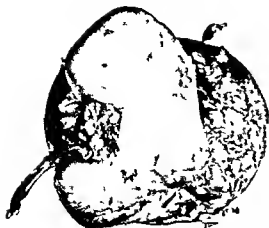


Fig. 5 Large solitary hemorrhagic cyst arising from the lower pole of the left kidney (Case 2)

Although solitary cysts are defined as occurring in a kidney otherwise normal, in 82 instances there was definite renal pathology in the same kidney (Table IV). This is a higher percentage than the figure indicates because of the frequent lack of any pathological report and of careful histological study of the kidney. It will be noted that chronic nephritis was present 31 times. This does not include the degenerative and sclerotic changes in the vicinity of the cyst which have been attributed to pressure. In 12 instances the kidney was definitely arteriosclerotic. In 3 the cyst arose from an infarct. Eighteen of the hemorrhagic cysts were associated with other conditions, 12 of which were tumors.

**CASE 1** A woman aged 50 years was admitted to the Seattle City Hospital, February 28, 1926 complaining of pain and soreness in the lower right quadrant of the abdomen. This had come on suddenly 2 days previously and was accompanied with nausea, vomiting and diarrhea.

The temperature on admission was 100 degrees F. There was no leucocytosis and the urine was normal except for a 0.7 per cent sugar and large amounts of acetone and diacetic acid. The blood sugar was 133 milligrams per 100 cubic centimeters.

Examination showed a mass in the lower right abdominal quadrant freely movable, not tender and with no overlying muscular rigidity. A diagnosis was made of fibromyoma of the uterus, diverticulitis of the colon and diabetes. The last condition was treated by diet and insulin and the patient's general condition improved.

On April 3 patient was referred to the urological service. The renal function as measured by phtha-



Fig. 6 Kidney after removal of the cyst showing its point of attachment to the lower pole and the small nodule of tumor tissue at this point (Case 2)

lein was 60 per cent the first hour and 10 per cent the second. The urine was normal except for sugar, acetone and diacetic acid. Plain X-ray pictures showed a faint irregular shadow about the size of a grape fruit in the right lumbar region, just above the iliac crest and after a barium enema a sharp displacement of the cecum and ascending colon inward and upward as if by a large, retroperitoneal tumor (Fig. 1).

On cystoscopic examination nothing abnormal was found in the lower urinary tract. The ureters were catheterized with no obstruction and the urines from both sides were normal. The function of the right was one half that of the left. Pyelo ureterograms showed a marked deformity on the right characteristic of tumor (Fig. 2). A tentative diagnosis was made of, first hypernephroma, second, monocyctic kidney.

**Operation April 5, 1926.** Because of the possibility of hypernephroma, Cabot's incision (transverse lumbal abdominal meeting a vertical mid rectus) was used and the right kidney, exposed extraperitoneally. The perirenal veins were markedly dilated. There was a large thick walled cyst on the external border and because of the impossibility of a resection a nephrectomy was done. The patient's recovery was uneventful.

**Pathological report.** The right kidney was enlarged and elongated and the external border replaced by a large thick walled cyst (Fig. 3). There was a reversal of the usual shape of the kidney, the internal border being convex with a resulting distortion of





Fig. 7

Fig. 8

Fig. 9

Fig. 7 Photomicrograph of cyst wall showing complete connective tissue substitution (Case 2)

Fig. 8 Low power photomicrograph of dilated atrophic renal tubules in the cyst wall (Case 2)

Fig. 9 High power photomicrograph of the tubules in the cyst wall showing the compressed atrophic tubular epithelium structure (Case 2)

the pelvis. The blood supply was abnormal (Fig. 4). The cyst had extremely dense thick walls with areas of calcification and contained a thick grumous material. Microscopically section from the wall showed dense fibrous connective tissue with occasional areas of calcification. Section from the kidney showed a patchy atrophy and sclerosis with atherosclerosis of the larger vessels characteristic of the atherosclerotic kidney of Ziegler.

**CASE 2.** A woman aged 36 years a patient of Dr. Homer Dudley was admitted to the Swedish Hospital November 16 1925 complaining of a dull aching pain and a mass in the left side of abdomen.

In the spring of 1922 she had had an attack of painful urination with frequency and burning. This was followed by a dull aching pain in the left lumbar region accentuated by walking and by lying on the left side. One month later there was a painless haematuria followed by chills and fever and some pain in the left loin.

Examination by physician showed blood and pus in the urine. A plain X-ray picture was negative for tumor or stone in the kidney. After 2 months all the symptoms disappeared until 2 years later when the dull ache in the back returned. This gradually increased until 1 year later the patient noticed a lump in the left side. There was no nausea or vomiting but some slight dysuria. The physical findings were essentially negative except for a large symmetrical freely movable firm painless mass in the left abdomen extending from beneath the border of the twelfth rib to the level of the crest of the ilium. The urine showed a trace of albumin many pus and red blood cells and bacteria.

Cystoscopy showed a normal bladder many pus cells in the left kidney urine as compared to a few in the right and a zero phthalein in 25 minutes from the left as compared to a 25 per cent output in the same time from the right. The left pyelogram showed a slight distortion of the lower calices but there was a large rounded shadow of the same density as the kidney shadow and apparently connected with the lower one half of the kidney. A diagnosis was made of solitary cyst of the kidney and pyelonephritis.

**Operation January 13 1926.** The left kidney was exposed through a left lumbar oblique incision. A large thick walled cyst arose from the lower pole. It was firmly adherent to the surrounding tissue. A nephrectomy was done without rupture of the cyst. The specimen (Fig. 5) consisted of a flattened kidney arising from the lower pole of which was a thick walled cyst about the size of a grapefruit. Its contents were haemorrhagic. The inner surface was roughened from attached fibrin and small masses of old blood clot. The cyst arose from the medulla near the tip of a pyramid (Fig. 6). At its deepest point of attachment was a small mass of yellowish friable tissue which microscopically proved to be hypernephroma. The kidney tissue immediately surrounding the cyst showed some atrophic changes. The cyst wall was one quarter centimeter thick and made up of fibrous connective tissue with some round cell infiltration (Fig. 1). There were areas containing atrophic dilated renal tubules (Figs. 8 and 9) and several atrophic glomeruli scattered throughout the wall were small masses of hypernephroma cells in strand between the fibrous con-



Fig 10 (left) Strands of tumor tissue such as were found in numerous areas in the cyst wall (low power photomicrograph) (Case 2)



Fig 11 High power of tumor tissue in the cyst wall showing the cellular arrangement typical of hypernephroma (Case 2)

nective tissue (Figs 10 and 11) The cyst had no epithelial lining

It is interesting to note that there was nothing in the gross specimen to suggest the presence of hypernephroma The cyst was indistinguishable from any large, simple cyst The presence of hypernephroma was demonstrated only after careful microscopic examination of the cyst wall

**CASE 3** A man aged 60 years, a patient of Dr R Mosman was admitted to the Seattle General Hospital February 28 1927 complaining of hematuria and a large mass in the right side of the abdomen For the past 2 years there had been a painless hematuria Just recently he noticed a mass in the right side of the abdomen which increased in size It was not tender and there was no lumbar pain

The examination showed nothing of importance except a large smooth mass in the right side of the abdomen extending from the inferior costal margin to the iliac crest It moved on respiration and was not tender On bimanual palpation it gave the definite impression of a kidney tumor The urine contained a trace of albumin a few pus cells and a few hyaline and granular casts A diagnosis was made of hypernephroma

**Operation March 1 1927** Because of the enormous size of the tumor the kidney was exposed transperitoneally A large cyst almost completely replaced the right kidney The remaining parenchyma was elongated and spread out over the external border of the cyst There was a marked enlargement and engorgement of the venous collaterals A nephrectomy was done without opening the cyst The patient was alive and well 1 year after operation

The specimen showed a large cyst 25 centimeters in diameter over the outer side of which were stretched the remains of the kidney measuring 7 by 4 by 3 centimeters (Fig 12) The contents were hemorrhagic At the middle point of the cyst's attachment to the kidney was a yellowish nodule of tumor tissue which on microscopic section proved to be an adenocarcinoma (Fig 13) The parenchyma in the vicinity of the cyst showed atrophic changes The cyst wall was thin and showed a complete connective tissue replacement (Fig 14) In numerous areas in the wall small strands of tumor tissue were found with the cellular arrangement of an adenocarcinoma (Fig 15)

Here again as in Case 2 we find a large, solitary cyst with remnants of tumor in the walls but indistinguishable on gross inspection from the simple, large hemorrhagic cysts not associated with tumors

**CASE 4** A woman aged 38 years a patient of Dr W Lippincott was admitted to the Seattle General Hospital December 13 1926 complaining of diarrhoea of 2 months duration Three weeks ago there was a sharp colic like pain in the lower left abdominal quadrant associated with nausea and vomiting

The general examination was essentially negative except for a firm smooth freely movable mass in the left upper quadrant There was no rigidity or tenderness The blood and urine were normal

Cystoscopy showed the lower tract to be normal The ureters were catheterized with no difficulty and the separate urines were normal and the divided functions equal and good Control X ray plates showed a shadow the size of a large orange continuous with the left kidney shadow Pyelograms showed the left pelvis to be slightly enlarged The



Fig 1. Large solitary hemorrhagic cyst of right kidney. Note the nodule of tumor tissue at the deepest point of the cyst's contact with the kidney. (Case 3)

lower major calyx was flattened and the entire pelvis pushed upward and inward. A diagnosis was made of simple cyst of the left kidney.

On February 11, 1927, a transperitoneal left nephrectomy was done through a rectus incision. A large cyst was attached to the lower one half of the internal border. It was impossible to excise it because of its intimate association with the renal pedicle (Fig 16).

The specimen showed a kidney 9 by 5 by 4.5 centimeters to the inner border of which was attached a thin-walled cyst 7 by 5 by 6 centimeters with serous contents. The cut surface of the kidney appeared normal. Microscopic section showed considerable edema and tubular degeneration. The cyst wall was thin and made up of fibrous connective tissue with some round cell infiltration.

**CASE 5.** A woman aged 59 years referred by Dr. M. W. McKinney was admitted to the Seattle General Hospital April 18, 1926, complaining of a dull pain and tenderness in the right upper abdominal quadrant with occasional attacks of nausea and vomiting. These attacks started 10 years ago and occurred about every 3 to 4 months.

The general examination was essentially negative except for marked tenderness below the right inferior costal margin. The urine was normal. There was a leucocytosis of 19,400 with 89 per cent polymorphs.

A diagnosis was made of cholelithiasis and an exploratory laparotomy done April 19, 1926. The gall

bladder was found to be normal. There was a cyst the size of a large lemon, attached to the lower pole of the right kidney. A transperitoneal nephrectomy was done. There was an anuria and the patient died of uræmia on the seventh postoperative day.

The specimen was a kidney 10 by 5 by 4 centimeters attached to the lower pole of which was a thin-walled serous cyst 5 by 3. The walls showed a complete connective tissue replacement. There was no epithelial lining. The kidney showed atherosclerotic changes with glomerular obliteration, scar tissue and endarteritis in some areas.

**CASE 6.** A man aged 66 years was admitted to the King County Hospital March 3, 1919, with third degree burns of both legs and feet. He developed a severe infection and toxæmia and died April 16, 1919.

**Autopsy report.** Chronic myofibrosis, parenchymatous degeneration, arteriosclerosis. The left kidney had a large solitary serous cyst 7.5 by 5 by 6 centimeters on the middle of the external border (Figs 17 and 18).

**CASE 7.** A man aged 64 years was admitted to the King County Hospital August 8, 1928, complaining of a pain in the epigastrium. A diagnosis was made of carcinoma of the prostate, renal calculus and chronic nephritis. The urine showed albumin, red blood cells, casts and 10 to 12 pus cells to the high dry field. The phenolsulphonphthalein was 20 per cent in 1 hour and 1 month later 10 per cent in 2 hours. The urea nitrogen was 83 milligrams per 100 cubic centimeters and the creatinin 4.8 milligrams per 100 cubic centimeters. He died of uræmia September 17, 1928.

The clinical diagnosis was confirmed at autopsy. In addition a large serous cyst associated with several smaller ones was found in an arteriosclerotic left kidney (Fig 19). It is the same sort of cyst that has frequently been reported under the title of solitary cyst. Yet it is unquestionably a nephritic cyst in an arteriosclerotic kidney. In size gross appearance and histologically it resembles in every detail the cyst shown in Figure 17 and differs from it only in that the etiology here is evident. In Case 6 it is not. It does not seem reasonable to exclude it from classification under the generic term solitary cyst simply because we know its origin.

#### THEORIES OF ETIOLOGY

Numerous explanations of the origin of these cysts have been given (36 and 200). In the more recent literature opinions are divided between the congenital theory and the idea that they are acquired retention cysts. The work of Kampmer (196) and of Reinhold (199) on the embryology of the uriniferous tubules is quoted in support of the contention that they develop from embryonic rests, persistent cystic tubules in the embryo or from the failure of union of the glomeruli and tu-



Fig 13

Fig 13 Photomicrograph of tumor nodule noted in Figure 12 showing the structure of an adenocarcinoma (Case 3)



Fig 14

Fig 14 The fibrous cyst wall (Case 3)



Fig 15

Fig 15 Cyst wall with small area of tumor tissue of same structure as that noted in Figure 13 (Case 3)

bules and that they are genetically related to polycystic kidney

There are various discrepancies in this theory. The disease is one of late adult life, the average age incidence being 45, and it is frequently found in the sixth and seventh decades. It is contended by supporters of the congenital theory that the cysts are slow growing and are not of sufficient size to cause symptoms until middle life, yet in a large percentage of cases considering the absence of clinical history in many the very rapid growth of the cyst over a period of a few weeks or months has been noted. It is not unusual to find a history as follows:

A sudden onset of symptoms referable to the kidney followed by a period of quiescence for a few months, a return of the symptoms, and the appearance of a small mass which increases rapidly in size. For example, in one case a cyst the size of a cricket ball was palpated and in 9 months it completely filled the abdomen. In another a cyst the size of a grapefruit increased to that of a full term pregnancy in 2 months. In another a movable kidney of normal outline was palpated. Three months later there was a cyst three or four times the size of the kidney.

This idea of the rapid growth of these cysts is contrary to the generally accepted opinion although Braasch (108) has referred to it. He

states "The rapidity with which these cysts grow is interesting. Patients not infrequently claim that they have noticed that the tumor which may be the size of an orange or larger, has appeared and grown to its present size within a few months. The etiology has not been determined and would make an interesting problem for someone."

In children these cysts are rare, both clinically and at autopsy. It is hard to reconcile these facts—that is, the age incidence of 45, the rarity in children at autopsy, the sudden onset of symptoms, and, in many instances, the comparative rapidity of growth with a theory which assumes that they start in early life, grow slowly, and therefore do not manifest themselves until the fourth or fifth decade. It would seem more reasonable to suppose that they were related in some way to the acquired renal lesions which are more common in middle life.

Many investigators support the theory that they are retention cysts and are due to some undiscoverable obstruction in the tubules with active renal secretion continuing distal to the lesion. The commonest obstruction is assumed to be a localized inflammation with peritubular sclerosis and contraction. This is, of course, recognized as the origin of the small, retention cysts of nephritis, but it is considered inadequate by many as an explana-

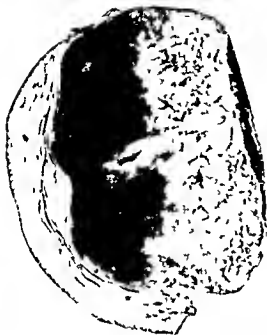


Fig 12 Large solitary hemorrhagic cyst of left kidney. Note the nodule of tumor tissue at the deepest point of the cyst's contact with the kidney. (Case 3)

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FIG. 19. Large serous cyst associated with several smaller ones in an arteriosclerotic kidney. In its gross appearance and histologically it resembles in every detail the cyst in Figure 17 and differs from it only in that the etiology here is evident. In Case 6 it is not (Case 7).

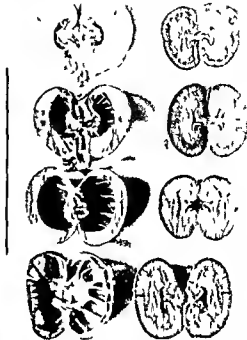


FIG. 20. Progressive development of hydronephrosis in direct proportion to the duration of the obstruction after complete ureteral block. The specimens at left represent 7 days, 14 days, 28 days, and 56 days of hydronephrosis in dogs after ligating the right ureter. At right, normal kidneys.

permanent, uniform, partial constriction of the renal artery was produced by a small piece of rubber tubing which was split and fastened about the artery (Fig. 21). This reduced the blood supply to the kidney to a degree, which, although it permitted urinary secretion to continue evidently at a greatly diminished rate produced rather a marked anemia.

When these dogs were sacrificed at varying periods and the hydronephrosis that followed ligation of the ureter was compared with control hydronephroses for the same period, it was found that there was a constant progressive increase in the rate of development that is despite anemia and evident reduction of urinary secretion when the artery was compressed the dilatation was much greater than when the blood supply was not disturbed. Figures 22 to 25 illustrate this variation.

It will be noticed that this increased rate of development was not occasional but was con-

stant and progressive throughout the series. This variation was accounted for by assuming that the anemia produced by the arterial compression resulted in a parenchymal degeneration which weakened resistance in the kidneys and permitted a more rapid process of distention. In other words, the anemia reduced tissue tone and favored relaxation to back pressure from ureteral obstruction.

**Group II—Arterial ligation plus ureteral obstruction (194).** The importance of blood supply to dilatation after ureteral obstruction was further demonstrated in another group of animals in which, in addition to tying off the ureter one branch of the renal artery was ligated. The renal artery is divided into an anterior and posterior branches. They are end arteries in the true sense of the word, so that ligation of either branch will result in infarction in the area which that branch supplies. Figures 26 and 27 demonstrate the area of contribution of the anterior and posterior branches



FIG. 16. Simple serous cyst of left kidney encroaching on the hilum and renal pedicle. (Case 4.)

tion of these larger cysts. Apparent discrepancies have been first that there is no evidence of any obstructive factor in many cases second that pathological lesions so situated as to block large groups of tubules are common yet solitary cysts are comparatively rare third that obstruction to the tubules at the papilla has been produced experimentally and that although there was dilatation which in some instances persisted no definite cysts were produced. In other words group tubular obstruction alone cannot cause these enormous dilatations which might be compared to



FIG. 18. Section of cyst showing the loss of kidney substance in its formation. (Case 6.)



FIG. 17. Solitary serous cyst of left kidney. (Case 6.)

blowouts of the parenchyma. There must be another constant factor.

I wish to review some experimental work on hydronephrosis, done in collaboration with Dr. Frank Hinman and published in 1923, which demonstrated a fundamental principle in the mechanism of renal dilatation following urinary obstruction. I feel that this principle can be applied to an explanation of the origin of large cysts of the kidney. For the sake of clearness it will be necessary to give here some of the details of this work (101, 192, 193 and 194).

#### THE CIRCULATORY FACTOR IN RENAL DILATATIONS

In a study of the development of hydronephrosis it was found that if a ureter is completely obstructed the degree of hydronephrosis which develops is in direct proportion to the duration of the obstruction (Fig. 20). With a standard uniform rate of development as a control it was possible to test the effect of various modifications of the renal secretion, such as diuresis, oliguria, splanchnotomy, compression of the renal vein, ligation of the vena collaterals, etc. on this rate. The most interesting and unexpected results were obtained in those experiments in which we directly modified the renal circulation by interference with the renal artery.

**Group I—Arterial compression plus ureteral obstruction (192).** For example, in one group of dogs after ligation of the ureter a

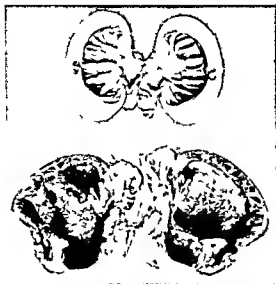


Fig. 23 Lower 21 day hydronephrosis in dog following complete ureteral block and partial compression of the renal artery upper kidney is used for comparison and represents the degree of hydronephrosis following simple ureteral block alone for the same period

These experiments established the importance of blood supply and local nutritional disturbances in the mechanism of renal dilations from urinary obstruction and also in the process of repair, which follows relief of obstruction. I feel that the principle involved can be applied to our understanding of the mechanism of the production of these large solitary cysts.

#### APPLICATION OF THIS PRINCIPLE TO THE PATHOGENESIS OF SOLITARY CYSTS

I was struck by the similarity not only of the gross appearance but of the histological structure of these experimental diverticula to the first case of solitary cyst which I have reported. This gave rise to the idea that the important factor, disturbance of blood supply in the mechanism of the production of the former might be concerned in the origin of the cysts.

Although group tubular block alone cannot produce them, it is conceivable in the light of the experimental work that if the same condition which produced the tubular obstruction interfered with the arterial supply to the same segment of the kidney introducing the factor

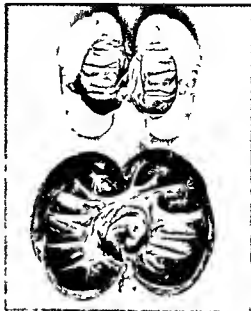


Fig. 24 Lower 28 day period hydronephrosis in a dog with partial compression of the renal artery, upper, simple hydronephrosis for the same period

of parenchymal anæmia and degeneration, which favors tissue relaxation and rapid dilatation, then a cyst might form.



Fig. 25 Lower 56 day period hydronephrosis with partial compression of the renal artery upper simple hydronephrosis for the same period used for a control.



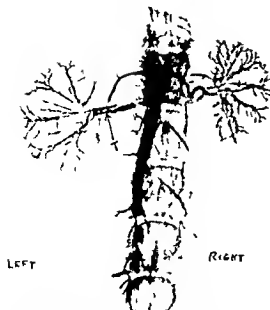


Fig. 21 Roentgenographic appearance of arterial barium sulphate injection of 7 day hydronephrosis of the left kidney of a dog with partial compression of the left renal artery. Thinning out of the arterial tree of the left kidney as compared with the right due in part to the compressing tube T which can be seen in place at the hilum.

in a rabbit's kidney. The pathological changes are those of anemic infarction, with cloudy swelling, hyaline degeneration followed by fibrosis and atrophy (Fig. 28).

When the ureter was ligated and the posterior branch of the renal artery tied off, the unique condition shown in Figure 29 was found after 14 days. The posterior one half of the kidney, which had been infarcted, ballooned out into an enormous diverticulum which communicated by a small opening with the hydronephrotic pelvis in the anterior one-half of the kidney the blood supply of which had not been disturbed.

Figure 30 shows a section of the sac or diverticulum and the fenestrum which opened into the pelvis of the anterior one half of the kidney. The same result was obtained in nearly all the rabbits on whom the combined operation was done. Figures 29 to 35 show the specimens for varying periods of obstruction.

That the location of these diverticula is dependent on the area of infarction is beautifully illustrated in the specimen shown in Figure 35. In this experiment, in addition to

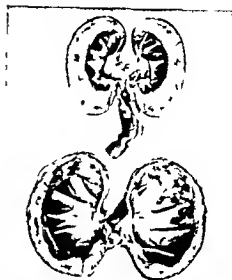


Fig. 22 Lower 14 day period hydronephrosis in a dog with partial compression of the renal artery. Upper kidney is used for comparison and represents the degree of hydronephrosis seen with simple ureteral obstruction for the same period. Remarkable acceleration in the rate of hydronephrotic atrophy when the artery is compressed.

the ureteral block, only a small arterial branch to the lower pole was sectioned, and the urinary back pressure besides producing a hydronephrosis in the normally vascularized portion of the kidney caused a blow-out which was limited exactly to the area which had been deprived of its blood supply. The sac wall in all instances was made up of fibrous connective tissue which was formed by the compression of the infarcted parenchyma by the urinary back pressure (Fig. 36).

What has happened in this group is that the urinary back pressure produced by ureteral ligation is exerted equally in all directions in the kidney and meets little resistance from the degenerated area, which has been deprived of its blood supply. As a result this balloons out into these enormous sacs, which can be compared with blow-outs.

In the first group, where the artery was compressed the anemia was uniform and the increased rate of dilatation general. In the second group where the one branch of the artery was ligated, the anemia was localized and complete (infarct), and the dilatation was correspondingly localized and extremely rapid.



Fig. 29 Gross specimen *in situ* 14 days after ligation of left ureter combined with ligation of posterior branch of renal artery. anterior half of kidney embedded in the large sacular dilatation of posterior half which has been deprived of its blood supply

weight unless it could be backed by experimental proof. Two investigators, Peterson (198) and Tollens (201), have attempted to produce cysts by obstructing the tubules, one with a silk suture about a papilla and the other by cauterizing the tip of a papilla. They obtained definite dilatation of the tubules but nothing which resembled a cyst.

If our conclusions are correct and if a localized arterial disturbance or parenchymal anemia is a factor in the formation of these cysts then its introduction is a simple matter by ligating one small branch of the renal artery in addition to blocking the tubules.

The rabbit's kidney is especially well suited for this type of experiment because it is a one lobed kidney and therefore has but one papilla (Fig. 38). It would be difficult in a multilobed kidney similar to the human to pick out one papilla for obstruction and then be sure in ligating one branch of the artery that the infarct would be in the same segment of the kidney. In the rabbit all the collecting tubules can be blocked at one time and when a branch of the artery is ligated urinary back pressure is sure to be exerted on the infarcted area. The following experiment was done.

**Protocol - July 19 5** The kidney in a rabbit weighing 3 kilograms was exposed through a lumbar incision. The papilla was everted through a small incision in the renal pelvis and was fulgurated thoroughly to block the tubules. This incision was

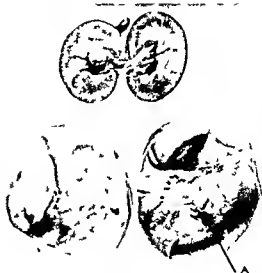


Fig. 30 Section of the diverticulum which was produced by simultaneous ligation of ureter and the posterior branch of the renal artery. 1 Opening into the hydronephrotic pelvis of the anterior one half of kidney the blood supply of which was not disturbed upper simple hydronephrosis for the same period



Fig. 31 Same condition as illustrated in Figure 30 for a 21 day period of obstruction. Sacular dilatation of infarcted posterior one half of kidney. 1 Opening which communicated with the hydronephrotic pelvis of the anterior one half, upper control 21 day hydronephrosis

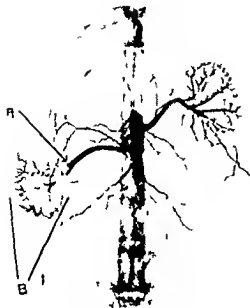


Fig. 26 Roentgenogram of a barium sulphate injection of the renal arteries in a rabbit. The anterior branch of the left artery has been divided between ligatures at A. The injection demonstrates the usual area of distribution B of the posterior branch.

In the experimental condition the urinary back pressure is produced artificially by ligating the ureter and the parenchymal anastomosis.

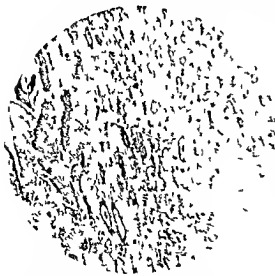


Fig. 28 Margin of infarct 7 days after ligation of posterior branch of renal artery. Lighter area to the right represents the infarct. Degenerative changes are marked.



Fig. 27 Sagittal section of injected kidney shown in Figure 26 demonstrating the relative distribution of the anterior and posterior branches of the renal artery. The posterior branch is injected.

by ligating a branch of the renal artery. In the cysts the intrarenal urinary back pressure is produced by group tubular obstruction and the parenchymal anastomosis by the implication of an arterial branch in the region of the block in the process (Fig. 37). With active glomerular function continuing distal to the lesion rapid dilatation takes place. The surrounding kidney undergoes a compression atrophy and produces the connective tissue wall of the cyst. In some instances the fibrous tissue substitution is complete; in others there are still remnants of parenchyma in the sac wall. The obstructive factor, whether it be obliterating endarteritis with peritubular sclerosis, atherosclerosis, infarct, tumor, or what not is involved in the process; hence all gross evidence that it was concerned in the formation of the cyst is eventually lost.

It is of course understood that the conditions mentioned are fairly common with well recognized pathological sequences. These lesions will produce a cyst only when they are so located as to cause group tubular obstruction with active glomerular function distal to the lesion and when because of them there is nutritional disturbance in the same segment of the kidney.

#### EXPERIMENTAL PRODUCTION OF SOLITARY CYST

An hypothesis of this kind, no matter how much the clinical features or pathological findings may support it, would carry little



Fig 36 Photomicrograph of wall of a diverticulum produced by infarcting portion of kidney and then blocking the ureter. There is a complete connective tissue substitution. Compare with wall of solitary cysts. Figures 7 and 42.

atherosclerosis, infarct, tumor, etc., which we assume could be etiological factors, might cause the combination of circumstances essential to cyst formation.

There is no question but that the mechanism described is operative on a small scale in the formation of the multiple small cysts in the arteriosclerotic kidney. The following is paraphrased from Mallory (197): "There is an obliterating endarteritis with sclerosis of the groups of arterioles and glomeruli and as a result nutritional disturbances of the adjoining parenchyma. The subtending tubules atrophy, and there is a connective tissue substitution. Small groups of tubules, the glomeruli of which are not involved become occluded by the peritubular sclerosis and there is dilatation with cysts." They are multiple because the process in the arteriosclerotic kidney is diffuse and small because the smaller vessels are involved. Hence the nutritional disturbance is confined to small area and the tubular obstruction to small groups.

It is conceivable that with occlusion of larger vessels large cysts might form on the same basis. This would be especially likely in the focal form of arteriosclerotic nephropathy (atherosclerotic kidney of Ziegler) in which the process is not diffuse, involves only certain of the renal vessels, often those of large caliber.

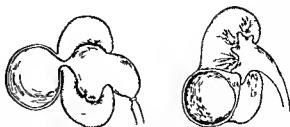


Fig 37 Diagrammatic comparison of mechanism of production of experimental diverticula and of solitary cysts. A Experimental diverticula. Urinary back pressure produced by ligating ureter and parenchymal anemia by sectioning one branch of renal artery. B Solitary cysts. Urinary back pressure (intrarenal) produced by group tubular block and parenchymal anemia by implication of an arterial branch in the same process which produced the tubular block.

The relationship of at least some of these large, serous cysts to nephritis cannot be denied. In 28 of the reported cases, there were definite nephritic changes, chiefly vascular. In 25, the larger cysts, reported as solitary, were associated with smaller ones, similar in every detail except size and indistinguishable from those seen in nephritis.

It is not contended that all large serous cysts arise on this basis, but it does not seem that size should preclude the possibility of some of them at least having this origin.

It is also conceivable that a single infarction from embolus or thrombosis might produce a cyst. In the majority of instances such a lesion results in a wedge shaped infarct with subsequent scarring and contraction. However, if one of the smaller vessels of the corticomedullary zone were involved and the lesion so situated as to have distal to it active, functioning glomeruli, then a cyst might form. The area of infarction undergoes a compression



Fig 38 Illustrates an unlobed kidney. Section shows single papilla at P.



Fig. 32 Section of anterior one half of kidney the blood supply of which has not been disturbed showing hydronephrotic pelvis which communicates with sacculated dilatation of the infarcted posterior one half of kidney seen behind Twenty-one day period of obstruction

closed with a fine silk suture. The posterior branch of the renal artery was ligated and the lumbar wound was closed. The rabbit was sacrificed after 18 days. Figures 39 to 41 show the condition found.

A cyst was produced similar in every way to the ordinary solitary cyst of the kidney. It did not communicate with the renal pelvis. The ureter passed behind it. It arose from the infarcted area. Figure 40 shows another view of the cyst with the ureter running behind it and the infarcted area.

A sagittal section of the kidney (Fig. 41) showed the normal pelvis, the place where the papilla was fulgurated and the thick walled cyst. The wall was made up of fibrous connective tissue (Fig. 42).

The confirmation of this theory of the mechanism of cyst formation is contained in the photomicro-

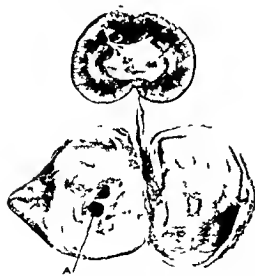


Fig. 33 Same condition as illustrated in Figures 29 to 32 for a 28 day period of obstruction. A Opening into the hydronephrotic anterior portion



Fig. 34 Anterior one half of kidney of the 28 day specimen. Note the hydronephrosis of the anterior one half which communicates with the diverticulum behind

graphs shown in Figure 43. It shows the normal parenchyma with dilated tubules for it must be remembered that all of them were obstructed in the papilla. There is also the area deprived of its blood supply with hyaline changes and degeneration and then the cyst wall arising from this area with a complete connective tissue substitution.

Let us briefly consider how the lesions obliterating endarteritis with peritubular sclerosis

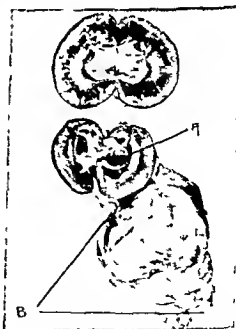


Fig. 35 Twenty-eight day hydronephrosis with ligation of anterior branch of lower pole effect of the increasing pelvic pressure on the infarcted area in this case limited to the lower one third of posterior one half of kidney. A Communication between dilated pelvis and diverticulum. B

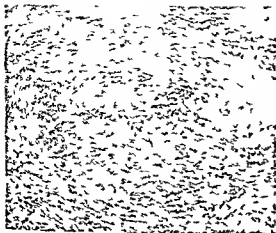


Fig. 42. Photomicrograph of cyst wall showing the same connective tissue replacement as occurred in the pelvic diverticulum produced experimentally and in the solitary cysts. F. Areas 7 and 36.



Fig. 43. Section at the point of contact of the experimental cyst with the kidney showing 1 normal parenchyma the blood supply of which was not disturbed but with dilated tubules from the obstruction produced by fulguration of papilla 2 area deprived of its blood supply by ligation of one branch of renal artery 3 wall of cyst which arises from this area.

encapsulated, and a small cyst form, but with such lesions as aneurisms, angioma and hybernephroma, frequently associated with these cysts, the bleeding would tend to be repeated and furnish the intrarenal pressure

#### SUMMARY

This conception can be briefly summarized as follows. These large, usually solitary cysts of the kidney are acquired. They are not a distinct entity with a common etiology but the mechanism of their production is essentially the same. Recognized pathological conditions of the kidney cause them but only when so situated as to produce a combination of group tubular obstruction and anemic degeneration of the parenchyma from circulatory disturbances in the same segment of the kidney. In some instances an additional factor is repeated prolonged hemorrhages into the same area.

This conception explains the variation in size, number contents cyst wall, and associated renal conditions on the basis of variation of the direct etiological factor—the amount of group tubular obstruction and the area of nutritional disturbance depending on the size and distribution of the vessels involved. It also explains the apparent absence of a direct etiological factor in some instances for the original lesion may become so involved in the

process that all evidence of its presence is eventually lost.

Among the clinical and pathological features of large, renal cysts which lend support to this hypothesis are

1 The average age incidence of 45 years, a period when vascular lesions as arteriosclerosis, endarteritis, aneurisms, infarcts, and acquired lesions, such as tumor are common.

2 The rather frequent association of these cysts with lesions, which might produce the conditions assumed to be necessary for their formation.

3 The frequent presence in the kidney containing a so-called solitary cyst of smaller cysts similar to the larger in every detail except size and indistinguishable from nephritic cysts.

4 The presence in the sac wall of groups of atrophied glomeruli and tubules indicating its origin from renal parenchyma, which has undergone a compression atrophy with a connective tissue substitution.

5 The presence of remnants of neoplasm in the walls of many of the hemorrhagic cysts as the only indication that tumor was concerned in their formation.

6 In many instances the sudden onset of symptoms, comparatively short clinical course,



FIG. 39. Solitary cyst produced experimentally in rabbit's kidney.

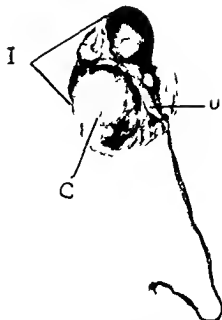


FIG. 40. Photograph illustrating *I* infarcted area from which arises *C* cyst *U* ureter passing over cyst.

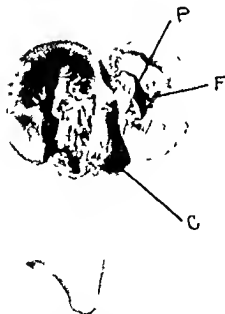


FIG. 41. Section of kidney showing *P* normal pelvis *F* area of papilla which was fulgurated *C* thick-walled cyst which does not communicate with pelvis. Portion of left half removed for microscopic section.

atrophy and becomes together with the compressed surrounding parenchyma the connective tissue wall of the cyst. Hence all evidence that it was concerned in its formation is eventually lost.

The same holds true for tumors. Neoplasms arising in the medulla might produce the combination of tubular block and arterial occlusion. When this occurs the area blows out into a large cyst, usually hemorrhagic because of the tendency for tumors to bleed. What would have been a hypernephroma or an angioma becomes a large solitary hemorrhagic cyst with barely discoverable remnants of tumor tissue in the walls. These are the only evidence of its origin because the original tumor became involved in the compression atrophy and together with the compressed surrounding parenchyma forms the wall of the cyst. The character of hemorrhagic cysts would suggest that in many, in addition to the tubular block, the intrarenal pressure is furnished by repeated hemorrhages into the parenchyma. A primary simple hemorrhage might become absorbed or if fairly large

- 91 LAQUETRE (S) J de chir 1925 xxxi 257-279  
 92 LEGUEL (S) Traite de urol chir p 845  
 93 LEJARS and SEBILEAU (H) Bull Soc anat de Par 1883, lxxi 626-630  
 94 LEOPOLD (H) Arch f Gynaek 1882a xix 129  
 95 LEVIN (S) Am J Psychol 1923 xi 73  
 96 LIPSCHEROFF (H) Folia urolog 1911 vi 375  
 97 LOCKYER (S) Proc Roy Soc Med Lond Sec Obst and Gynec 1912 p 97  
 98 LOFFLER (S) J Ztschr f urol Chir 1927 xv 407  
 99 LOREDDI (S) Gazz de osp 1922 xliii 380  
 100 LUDWIGS (S) Ztschr f urol Chir 1928 xvi 13-20  
 101 MAGNAN (S) Quoted by Harpster loc cit  
 102 MALBONNEVE (H) Quoted by Souligoux and Goulet loc cit  
 103 MALHERBE (S) Ann d mal d org genito urin 1890 xiv 268  
 104 MANNA ARTURO (A. TONICCI) (H) Polichn 1927 xiv 477-500  
 105 MAZZONI (S) Quoted by Brin loc cit  
 106 McARDERL (S) Dublin J M Sc 1894 March  
 107 McCONNEL (S) Dublin J M Sc 1920 cclxxx  
 108 McKIN and SMITH (S) J Urol 1924 vii 635  
 109 McMURTRY (S) Amer Intract & News 1893 xv 515  
 110 MEADOW (S) Brit M J 1871 ii 44  
 111 MENDELSON (S) Ztschr f urol Chir 1913 i 295  
 112 MINET (S) J Ass franc d urol 1911 vi 94  
 113 J d urol méd et chir Par 1921 xii 581  
 114 MOLLIERE (S) Lyon méd 1876 xxi  
 115 MONTELUPT (S) Rev méd de Normandie 1908 p 140  
 116 MORRIS (H) Disease of Kidney London 1901  
 117 MORTON (S) Lancet 1908 ii 520  
 118 MOSTI (S) Gazz d osp Milano 1922 xlii  
 119 MONTANAN (S) Brit M J 1902 i 263  
 120 MOWBRICK (S) Quoted by Hoffman loc cit  
 121 NICOLAISEN (S) Acta chirurg Scand 1923 lvi 235  
 122 NIOSI (S) Riv urol Catania 1910 p 354  
 123 OLLIFF (S) Quoted by Brin loc cit  
 124 O'NEIL (S) J Urol 1925 xiv 269-273  
 125 ORLANDO (S) Am J Surg 1920 vi 241  
 126 ORSONO (S) Quoted by Dozza loc cit  
 127 PAPIE and CHRISTIAN (S) J Rev de gynéc et de chir abd 1911 xvi 3  
 128 PARMENTER (S) J H I New York State J Med 1921 xxi 73 J d Urol 1924 xii 660  
 129 PASQUEREAU (S) Gazz méd d Nantes 1913 xxxi 341  
 130 PATEL and GUY WALLEY (S) J d urol 1925 xix 316-320  
 131 PAUS (S) Deutsche Ztschr f Chir 1914 cxxvii 27  
 132 PAVR (S) Deutsche med Wchnschr 1910 xxxvi 197  
 133 PEAN (S) Quoted by Simon loc cit  
 134 PELLER (S) Tr Fifth Internat Surgical Congre 1881 v 2  
 135 PETERSON (S) Brit M J 1886 i 309  
 136 PIQUET (H) (S) Quoted by Souligoux and Goulet loc cit  
 137 PIGNATTI (S) Bull Soc med Bologna 1908 i 101  
 138 PIOL (S) Gazz d osp Milano 1923  
 139 PIRON (H) Arch de méd expér 1903 xv 219  
 140 PIRER (H) Bull Soc anat de Par 1888 lxxi 52 53  
 141 PIRLOW (S) Brit M J 1913 i 854  
 142 QUINBY (S) Boston M & S J 1925 cxcv 4, 0 454  
 143 KATHLIN (S) Quoted by Simon loc cit  
 144 RICCONIER (S) Ann d mal d org genito urin 1903 xi 95  
 145 REINCKE (S) Arch f path. Anat 1925 cclxx 423  
 146 REYD (S) Ann de gynéc et obst Par 1898, xlv 159  
 147 RICARD (S) Quoted by Simon loc cit  
 148 ROCHET (S) Quoted by Brin loc cit  
 149 ROLANDO (S) Arch ital de urol 1927 iii 267  
 150 SANTORO (S) Riforma med 1926 xliii 267-270  
 151 SARASIN (S) Arch mens d obst et de gynéc 1913 iv 341  
 152 SAVIOZZI (S) Quoted by Dozza loc cit  
 153 SCHETTLIG (H) Arch f gynéc 1880 o p 416  
 154 SCHULMAN (S) New York M J 1916 civ 218  
 155 SEITZ (S) Quoted by Simon loc cit  
 156 SEMM (S) Nord med Ark 1903 xxxi 0  
 157 SENDLER (S) Quoted by Simon loc cit  
 158 SERRES (S) Quoted by Simon loc cit  
 159 SIMONCELLI (S) Polichn 1927 xiv 105  
 160 SIREDA (H) Bull Soc anat Par 1889a xxxiii 446  
 161 SIEGLER (S) Quoted by Simon loc cit  
 162 SMITH G G (S) Boston M & S J 1924 cxc 691  
 163 SMITH L D (S) Illinois M J 1927 lvi 291-295  
 164 SOULIGOUX and GOULET (H) Arch d méd 1903 i 833  
 165 STROEDER (S) Quoted by Dozza loc cit  
 166 STERLING (H) Deutsche Arch f klin Med 1889  
 167 SWARTZ (S) J Urol 1925 xiv 307  
 168 TIERRIER (S) Rev de chir 1890 x 545  
 169 THOMAS (S) J Urol 1927 xviii 528 530  
 170 THOMPSON (S) Tr lath soc Lond 1861 xiii 128  
 171 TOUREN (S) J Thesis de doct 1865 Simon (200)  
 172 TOWERS (S) Lancet 1884 i 13  
 173 TUFFIER (S) Vich gén de méd 1891 ii 5  
 174 VASSIERE (S) Quoted by Dozza loc cit  
 175 VIETHEN (S) Zentralbl f Chir 1926 lvi 2652-2657  
 176 VILLARD (H) Beitrag Zur Carcinistik Nierenstrumen Inaugural Dissertation Griefswald 1891  
 177 VOGEL (S) Zentralbl f Chir 1912 xxxix 1540  
 178 VONCHER and SPENGLER (S) Illinois M J 1927 li 413-415  
 179 WAGNER (S) Arch f klin Chir 1884 xv  
 180 WALKER (S) Proc Roy Soc Med Lond Sect Urol 1923 xvi 45  
 181 WALTER (S) Brit M J 1883 ii 615  
 182 WATSON (S) Quoted by Brin loc cit  
 183 WEIL (H) Ann Surg 1907 lvi 418  
 184 WEIL MOURIQUAND and GUARDIERE (S) Podiatre prat 1912 p 203  
 185 WELF (S) Deutsche med Wchnschr 1910 xxxvi 22  
 186 ZACARI (S) Deutsche Ztschr f Chir 1915 cxxvii 205  
 187 ZIESSLER (S) Internat J Surg 1914 xxxvii 252  
 188 ZISSLER (S) Ztschr f urol Chir vii 123

## ADDITIONAL REFERENCES

- 189 ARAN Surg Gynec & Obst 1926 xliii 155  
 190 BRANCH J Urol 1920 xvi 431  
 191 CRUTELLER FRANK Med Klin 1927 xxxiii 1447  
 192 HENKIN and HEPLER Arch Surg 1926 xi 578  
 193 Idem Arch Surg 1925 xi 649  
 194 Idem Arch Surg 1925 xi 917  
 195 Idem Arch Surg 1926 xi 830  
 196 KATZ (S) Arch f klin Chir 1928 clix 717  
 197 KAMPMER Surg Gynec & Obst 1923 xxxvi 204  
 198 MALLORY Principles of Pathologic Histology 1914 pp 567-570  
 199 PETERSON Quoted by Caulk loc cit  
 200 REINCKE Johns Hopkins H p Bull 1922 xxxiii  
 201 SIMON Thesis de doct 1906  
 202 TOLLENS Quoted by Caulk loc cit



and rapid growth of the cysts which can be easily understood in the light of the experimental work in which the enormous diverticula formed in a few days.

Finally by creating experimentally the conditions assumed to be necessary for cyst formation, we have been able to reproduce a large solitary cyst similar in every detail to those found in the human kidney.

Since the completion of this paper solitary cysts of the kidney have been reported by Cubert Hueper Lewis and Carroll, Lucio Reluzzi Salteras and Secretan.

I wish to express my thanks to Drs Dudley Mossman Lippincott and McKinney for permission to study their specimens and to report their cases (Cases 2 3 4 5).

# TABLE I - CASES REPORTED AND REFERENCES -(S) SFROUS (II) HLMORRHAGIC

- 1 ABEL (S) Urol & Cutan Rev 1916 vi 617
- 2 ALBARRAN (S) Les Tumeurs du Rein Paris Masson
- 3 ALESSANDRI (S) Brit J Surg 1926 xiv 175
- 4 ANGELL (S) Arch ital di chir 1923 vi 299
- 5 ANTONI D (S) Quoted by Brin loc cit
- 6 ANZILOTTI (S) Quoted by Dozza loc cit
- 7 ARCHER (S) Lancet 1882 i 1070
- 8 ASCHNER (S) Am J Surg 1918 v 83
- 9 BAA (S) Quoted by Simon loc cit
- 10 BARDENHEUER (S) Deutsche med Wchnschr 1891 xlii 45
- 11 BARNEY (S) New England J Med 1928 cxix 278
- 12 BEGG R CAMPBELL (II) Brit J Surg 1926 xiii 649-653
- 13 BEGOUTIN (S) Gaz hebdomadaire de médecine de Bordeaux 1900 xxx 605
- 14 BEHNER (S) Quoted by Simon loc cit
- 15 BELLAMY (II) Brit M J 1888 ii 1045
- 16 BENECÉ (S) Centralblatt f allg Path u path Anat 1910 xxi 906
- 17 BERGMANN (S) Quoted by Simon loc cit
- 18 BEYERS (S) Brit M J 1914 i 702
- 19 BLANC (S 2) J durol 1925 xix 5-12
- 20 BLANCHARD (S) Rev de chir 1913 xlvii 913
- 21 BOCKENHEIMER (S) Berl Klin Wchnschr 1912 xlviii 1345
- 22 BOLDT (S) Am J Obst 1906 liv 864
- 23 BONNEAU and HARTMANN (S) Quoted by Simon loc cit
- 24 BOTREAL ROUSSEL (S) Bull et mém Soc anat de Paris 1922 xvi 371
- 25 BOTTO MICCA (S 6) Policlin Rome sez chir 1928 xxxv 303-317
- 26 BRACKEL V (II) Samml Klin Vortr 1899 ccl 1375
- 27 BREWER (S) J Am M Ass 1908 xi 715
- 28 BRIN (S 2) Ass franc durol 1911 xv 33
- 29 BRUN (S) Ztschr f Urol 1907 i 388
- 30 BURGESS (S) Quoted by Simon loc cit
- 31 CAMPBELL (S) Edinburg M J 1864 p 36
- 32 CAPORALI (S 2) Arch ital di chir 1922 v 663
- 33 CARSON (S 3) II 1) Ann Surg 1928 lxxvii 250-256
- 34 CASSIOLI (S) Riv osp 1917 vii 151
- 35 CASTANO and ASTRALDI (S) Rev de e pec. med 1927 ii 81
- 36 CAULK (S) Tr Am Ass Genito-Urin Surg 1911-1912 vols vi and vii
- 37 CHIVERTAI (S) Clin chir 1916 xiii 964
- 38 CLUTE (S 3) Surg Clin N America 1924 Decem ber p 1453
- 39 COLSTON (S) J Urol 1928 xix 283
- 40 QUARTRE (S 4 II 1) New England J Med 1915 cxviii 278
- 41 CRAMER (S) Quoted by Simon loc cit
- 42 CROSBIE (S) New England J Med 1928 cxix 2
- 43 CULLINGWORTH (S) Quoted by Brin loc cit
- 44 CUNNINGHAM (S 8 H 1) Surg Gynec & Obst 1916 xlviii 688
- 45 CZERNA (S) Arch f Klin Chir 1904 xlv 53
- 46 DELSKAMPF (S 2) Beitr z Klin Chir 1904 xlv 38
- 47 DE LORE and GUY MALLET (S) Lyon chir 1923 xxi 3-10
- 48 DESCHAMP (S) Quoted by Simon loc cit
- 49 DOUGLAS (S) Ann Surg 1922 lxxvi 856
- 50 DOZZA (S 3) Ztschr f urol. Chir 1921 xvi 10-19
- 51 DUFAY (S) Quoted by Simon loc cit
- 52 DUPRE (S) Bull Soc anat de Par 1888 lxii 447
- 53 LAYLANDER (S) Arch f Klin Chir 1902 lxi 111
- 54 ECHVERRY (H 2) Thèse de doct. 1909 p 73
- 55 FABRICIUS (II) Deutsche Ztschr f Chir 1911 cxlii 323
- 56 FOWLER (S) New York M J 1911 xxi 1109
- 57 FRYSSMAN (S) Quoted by Dozza loc cit
- 58 FULLERTON (S) Brit J Surg 1927 xvi 629-633
- 59 GIORDANO (S) Policlin Rome sez chir 1918 xxi 318-322
- 60 GILBERT (S 1 II 1) J durol 1913 i 619-627
- 61 GLAS (S 2) Quoted by Dozza loc cit
- 62 GOCCEV (S) Med Klin 1923 xxi 1883-1886
- 63 GRANTZ (II) Arch f path anat 1883 xciii
- 64 GUY (S) Quoted by Brin loc cit
- 65 GUTERAS (S) Urology 1922 i 493
- 66 HAENTSEL (II) Fortschr d d Geb d Roentgenstrahl en vol xi p 300
- 67 HARE (S) Tr Path Soc Lond 1830-1831 ii 199
- 68 HARMES (S) Beitr z Klin Chir 1922 cxiv 688
- 69 HARTMANN (S 2) J Urol 1924 xi 137
- 70 HARTMANN (S) Trav de chir anat-chir 2d ser
- 71 HERZEL (S) Beitr z Klin Chir 1890 vi 439
- 72 HERZEL (S 1 H 1) J Urol 1924 xi 663
- 73 HIRSHMAN and JOHNSON (S 2) Personal communication
- 74 HOFER (S) Muenchen med Wchnschr 1922 lxxvii 1279
- 75 HOFFMAN (S 4) Inaugural Dissertation Konigsberg 1895
- 76 JOSEPH (S) J Urol 1927 xvi 245-247
- 77 JOWERS (H) Quoted by Simon loc cit
- 78 JUNG and SIMON (H 2) Surg Gynec & Obst 1927 xvi 607-609
- 79 KEELING (S) Brit M J 1881
- 80 KELLER (S) Bull Soc d obst et de gynéc de Par 1912 xi 654
- 81 KELLY and BURNHAM (S 2 II 1) Diseases of the Kidney Ureters and Bladder 1914 vol 2 p 272
- 82 KEMMEL (S) Quoted by Brin loc cit
- 83 KIPPEL and LEFAS (S) Quoted by Simon loc cit
- 84 KIRKEN (S) J Urol 1926 xv 273-287
- 85 KRETSCHMER (S) J Urol 1920 vi 361
- 86 KROENLEIN and WYSS (H 1) Quoted by Fabricius loc cit
- 87 KRUSEN (S) Am Med 1906 lxx 574
- 88 LADINSKY (S) Med Rec N Y 1906 lxx 574
- 89 LANGEREAUX (H) Bull Soc anat de Par 1858 xxxii 203
- 90 LANG (S) Quoted by Dozza loc cit

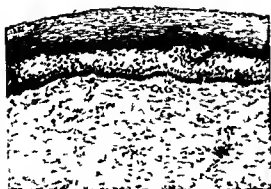


Fig. 14 A normal squamous epithelial covering (cervix). Total depth small. Relatively wide depth of compressed surface cells. Lack of intermediate semicuboidal cells. Lowermost layer low columnar in type. Complete lack of inflammatory reaction. A thin layer of cells corresponding to stratum granulosum beneath superficial cells.



Fig. 15 Squamous epithelium showing first an excessively thickened and keratinized superficial layer and second a definite stratum granulosum. Photomicrograph of section which was taken from a hypertrophied cervix which possessed an excessively thickened skin like covering.

say that it is made up of cells which are distinct morphologically from those of the malpighian layer, and are of the columnar type, though often cuboidal in shape, a fact which I attribute to an excessive degree of pressure.

The cervical squamous epithelium occasionally shows a well marked stratum granulosum running between the flattened superficial cells and the malpighian layer. This is, however, but poorly marked in the majority of cases, as compared with that observed in the squamous epithelium of normal skin, and if as according to Ranvier the granules of eleidin which these cells contain are used for transference into the keratin of the more superficial strata, it would appear that their function is not so necessary in the case of the cervix which has a relatively soft surface, as it is in the case of skin. In Figure 14 one may observe a thin line of cells in this position which stain rather more deeply than do the cells of the malpighian layer immediately below them.

Figure 15 is taken from a hypertrophied cervix possessing an excessively thickened surface, the superficial flattened cells of which have more right to the term *stratum corneum* than have those of the vast majority of cervixes. Here one may observe a very definite stratum granulosum, activity on the

part of which has evidently been called for in the supply of keratin for the excessively thickened and horny superficial layers. I consider however that activity on the part of the cells of the stratum granulosum is largely functional in this way, and I do not believe that they are concerned in any way with the cancerous reactions of this epithelium as a whole.

The basal columnar cells of the malpighian layer however react by proliferation to irritative stimuli. An inflammatory reaction in association with these cells produces multiplication of them by cell division. A percentage of the cells thus produced become displaced from immediate contact with the irritant and revert to passivity. New basal cells continue to proliferate. The thickness of the epithelial covering is increased and the new cells out of contact with the irritant take up an intermediate position between the stratum granulosum and the lowermost layers. These newly formed cells possess nuclei and cytoplasm which stain deeply. They are polyhedral in shape and have relatively thin walls. These new cells, now intermediate in position are seen to be undergoing gradual flattening as they near the surface, i.e., as they become relatively old. Their walls become gradually thicker and their nuclei and cytoplasm gradually diminish in amount.

# AN INQUIRY INTO THE BASIC CAUSE AND NATURE OF CERVICAL CANCER<sup>1</sup>

## II THE RELATION BETWEEN CERVICITIS (EROSION OF THE CERVIX) AND CERVICAL CANCER

A. A. BAILEY M.C. M.D. CH.B. MANCHESTER ENGLAND

### THE RELATIVE AGE, FUNCTION AND STABILITY OF SQUAMOUS AND COLUMNAR CELLS—METAPLASIA

**T**HERE is no doubt that epithelial cells concerned in the covering of tissue surfaces, being produced at varying stages in the formation of the structure to which they belong may be said to possess a certain age relation to one another—a distinction by no means as definite as that existing between true embryonic cells and adult tissue cells but analogous to that represented by the distinction between say spindle cells and adult muscle fibers often observed in association. For instance it is obvious in dealing with squamous epithelium that the upper and outer layers of cells are older than the lower and deeper ones. In the cervix uteri the outer layers of squamous cells are progressively flattened until those at the surface have become compressed into a thick protective covering of toughened tissue composed of the membranes of the cell walls concerned and containing scattered compressed nuclei. The surface of the cervix however usually remains smooth and fleshy, and in this way is distinctive from a tissue such as the skin which is similarly covered histologically but which possesses a hardness to its surface due to the keratin in the stratum corneum which is present in very minor degrees in the superficial cells of the cervix. Immediately below this outer covering there is a layer varying in depth consisting of semi flattened cells possessing thick walls no protoplasm and ill defined nuclei. This layer merges insensibly into the polyhedral type of cell which makes up the bulk of the epithelial structure. The protoplasm and nuclei of these cells stain well. The lowermost layer, one cell in thickness, immediately abutting on to the subjacent tissues is columnar in type, though often cuboidal in shape. The

most active cells of this epithelial structure are those of this deepest layer. It is from these columnar cells that new polyhedral cells are produced in the event of proliferative activity. The nuclei of the lowermost polyhedral cells stain more deeply and sharply than the more superficial ones. The same may be said of their protoplasm. These facts are indicative of youth on the part of these cells. The nearer the polyhedral cells are to the basal columnar layer, which is a primary layer, the newer or younger they are. As one proceeds toward the surface one observes the fading of the protoplasmic contents of the cells, together with the diminution in density and distinctness of this nuclei. This aspect is tantamount to the passage from activity to passivity and proves the fact that the polyhedral cells possess only the mechanical protective function. Eventually these cells merge into the flattened type above mentioned. Cell production is carried on at the base of the epithelium the former basal cells being forced upward toward the surface.

A normal epithelial covering one which has not been called upon to exert cell activity, should therefore consist of a narrow band of cells a relatively wide portion of which should be composed of extremely flattened surface cells—significant of long standing quiet on the part of the deepest layer—and no intermediate newly formed cells of the type just described.

Figure 14 shows a normal unaffected squamous covering to the cervix. The superficial compressed or semi horny layer occupies approximately half of the total depth of the epithelium and abuts directly on to the cells of the roalpighian layer, the lowermost layer of which is composed of cells of a low columnar type. This is often the case though by no means always is the lowermost layer definitely of a columnar type. One might, however,



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Figure 14 shows a normal unaffected squamous covering to the cervix. The superficial compressed or semi-horny layer occupies approximately half of the total depth of the epithelium and abuts directly on to the cells of the malpighian layer the lowermost layer of which is composed of cells of a low columnar type. This is often the case though by no means always is the lowermost layer definitely of a columnar type. One might however,



Fig 18 High power view of the primary cell division among the basal columnar cells. One may observe the process of nuclear division. The basal layer has begun to divide into two over a limited area.



Fig 19 The low columnar cells of the basal layer of adjoining squamous epithelium encroaching by extension on to the old erosion area. Commencing regeneration of squamous epithelium originating from the basal layer.

surface infection, with failure to respond to the irritative stimulus. Desquamation results, due to maceration of sensitive cells beneath them. The younger cells however, react in various ways according to the stimulus imposed. They are therefore unstable by comparison, and their instability to a given stimulus appears to be the greater the younger they are.

The all important layer from the functional point of view, is the lowermost, that composed of the columnar type of cell. As I have previously said, the actual height of the cells composing this layer may vary enormously. It is to be readily understood that a columnar cell situated between an epithelium many layers in thickness and dense mesoblastic tissues is subjected to varying degrees of pressure along its length and this fact no doubt plays an important part in the determination of the actual height of the cells concerned. In any case however there is no doubt but that the cells concerned in this basal layer one cell in thickness are of the columnar type even though many instances may show them to be of a low columnar variety or even cuboidal. A very large percentage of cases however show regular and very definite columnar cells in this situation though of a small and closely packed type.

I say that this is the all important layer functionally because I believe that it is di-

rectly concerned in the production of the new (young) cells of the malpighian layer (rete mucosum). The study of my cases has shown me that it is by a primary cell division of these columnar cells that the proliferative changes are instituted in that region of the epithelium affected by the irritant stimulus. Active and repeated cell division on the part of these columnar cells leads to the production of cells of the polyhedral type which go to the formation of the new lower layers of the rete mucosum.

Figure 17 shows a case in which an other wise perfectly normal squamous epithelium one that has hitherto been unaffected by irritative stimuli and which exhibits histological characteristics similar to that described in Figure 14, is subjected to an inflammatory reaction of low degree, as evidenced by a relatively loose leucocytic infiltration immediately in contact with its basal layer. In the area shown one may observe the very beginnings of proliferative cell division taking place in the columnar cells of this layer. Under the low power the basal layer is seen to present a localized thickening and 'double' appearance due to the primary division of the columnar cells. Under the high power magnification (Figure 18) one may definitely observe the process of nuclear

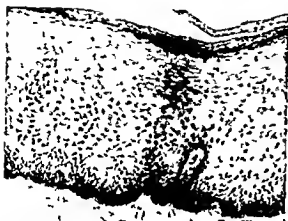


Fig. 16 The effect of a low grade irritant on the epithelial covering. The epithelium is much thickened. The superficial compressed layer is relatively thin. The new intermediate cells of the malpighian layer are very well marked.



Fig. 17 A low grade infection irritating the basal layer of a normal squamous epithelium. Proliferative cell division among columnar cells leading to formation of new cells of rete mucosum. A loose leucocytic infiltration beneath epithelium. A localized doubling of basal layer.

and concentration the farther they are situated from the basal cells from which they have sprung. Obviously a gradual retrogression due to advancing age in association with entire lack of function.

A squamous epithelial covering, therefore, which exhibits these intermediate cells in fair degree, thereby lessening the relative thickness of the superficial compressed layer shows histological proof of its having been subjected at one time or another to an irritative reaction affecting its basal layers. The greater the thickness occupied by these intermediate cells the more the proliferation that has occurred from the basal layer and consequently the longer has the irritation been continued. Examples of this type of mild reaction are to be found in long standing hypertrophies of the cervix in the causation of which a low grade infection has played a part.

Figure 16 is taken from a case of this type. The squamous epithelium here shows its reaction to a low grade infection which has become subdued and the evidences of which are now extinct. One observes the increased thickness of the covering epithelium. This is almost entirely due to the intermediately placed relatively young cells which can be seen to change gradually as they near the surface from possessing the histological fea-

tures of the new cell to that of the older surface cell. It will be noticed that during the course of this change the cells lose their cytoplasm much more readily than their nucleus which still remains even in certain of the cells which have passed to the stage of almost total compression. The thickened epithelium is again lined basically with a low columnar type of cell, quite distinct from those in immediate contact with it showing that this primary layer reasserts itself as such after activity ceases.

In any given squamous epithelium therefore the youngest or most recently produced cells are those situated at the base of the malpighian layer or rete mucosum in contact with the basal columnar layer. The nearer the surface a squamous cell is the older it is. A 'young' or recently produced cell is relatively rich in the density of its cytoplasm. Its nucleus stains deeply and appears to be large on account of the relative smallness of the newly produced cell. Moreover we shall see that the younger a cell is the less stable it is. The older cells toward the surface of the epithelium those that have lost their cytoplasm and whose walls are becoming thickened are incapable of reactive changes. Their nuclei if still present are inert. One may frequently observe instances in which these older cells are in contact with



Fig. 22 (left) An irritant of first virulence attacking squamous epithelium. Relative depth of the infiltration is shown together with the slight reaction on the part of the adjacent epithelium.

Fig. 23 Contact site between squamous epithelium and irritant. Rupture of the basal columnar layers by the irritant. Local destruction of cells without reaction. Masses of macerated epithelial cells in the inflammatory exudate.

cells of the columnar type which first form the contact. These are primarily derived from the columnar epithelial cells of adjoining cervical glands by extension (see Fig. 4 low power, and Fig. 18) which are even more resistant to maceration than the columnar cells of the squamous basal layer but are later replaced by these basal cells which extend from the base of the adjoining squamous epithelium and always precede the reformation of the new squamous covering. This fact is exemplified in Figure 19. Here one may observe this basal layer growing upward to the surface of the old erosion. It maintains its morphological character in so doing although the height of the cells is not quite equal to that which normally appears. There is a complete absence of surface inflammatory reaction in this case, so that the new columnar epithelium has been allowed to travel a relatively long distance without reacting to an irritative stimulus. A long strip of cells therefore, has thus grown out from the adjoining squamous epithelium. The furthestmost cells consist of only the one layer, basal cells themselves but as one approaches nearer to the original epithelium this layer becomes two or three cells in thickness and there are isolated regions in which its thickness is locally increased to four or five cells. It is noticeable that the columnar

type of the cell is definite where the layer is only one cell in thickness, but that the base of the thickened regions is composed of cells which are more cuboidal in shape. This I consider is undoubtedly due to the phenomenon of cell division having taken place in the basal layer with the consequent reproduction of polyhedral shaped cells which are extruded to the surface to become squamous



Fig. 24 The edge of an active ulcer. Old squamous epithelium. Subepithelial acute inflammatory infiltration of approximately one third the density of the destructive force. Sharp epithelial downgrowths. Intact basal columnar layer showing metaplastic activity and protective function.





Fig. 20 (left) The normal junction between squamous and columnar epithelia at the region of the external os

Fig. 21 The external os. A junction between the squamous and columnar epithelia. A subepithelial inflammatory reaction causes reactive thickening of the squamous but no change in the columnar epithelium

division in many of the primary cells. The nuclei of these primary columnar cells are elongated in shape. After division the nuclei of the resultant cells are still elongated but it is possible to observe a rapid transition on the part of the newly produced cells to the polyhedral type after complete separation from the parent cells with a consequent rounding of the nucleus. This phenomenon takes place in the cells produced away from the base of the parent cell. The new basal cell retains its columnar shape definitely if the irritation to which it is subjected is very slight and its reactive activity consequently slow, not so definitely if the irritation is intense, thus calling for rapid metaplastic activity. In this case the new basal cells tend temporarily to lose their definite columnar shape in the stress of severe involvement but in all cases the true histological nature of this layer can be traced in lesser involved areas, and in all cases the type is definitely resumed on the cessation of activity. I will therefore, assert that irritation below that of a destructive virulence affecting the columnar celled basal layer of the squamous epithelium as evidenced by an inflammatory reaction in the vicinity, results in a true metaplastic activity on the part of these cells whereby they progressively produce new cells of the

polyhedral type which are themselves physiologically inert but which, on account of their youth are highly unstable in their powers of resistance to irritation. The proof of this assertion I hope to show as we proceed.

With regard to age of the cells entering into the composition of the squamous epithelial covering therefore, one may say that the basal columnar layer is the primary layer—that from which the epithelium is produced and hence its cells are the oldest. Moreover they possess a physiological function, that of cell production by metaplasia. For the rest the oldest squamous cells are those at the surface the youngest at the base, and these are as yet polyhedral. Squamous and polyhedral cells have no physiological activity. Their function is purely mechanical—a protective one.

Like all cells however, they exhibit the phenomenon of proliferation as a response to irritation and this phenomenon is more readily observed in the newly formed cells of the squamous epithelium than in the older ones—a fact which demonstrates the relative instability of the youthful cell.

In the commencement of healing of an erosion or even of ulceration of the cervix when the elements of epithelium again begin to cover the erstwhile inflamed zone, it is



Fig 27 Long bulbous downgrowths resulting from continued irritation of the squamous epithelium from below by an irritant of the third degree of virulence



Fig 8 Large irregular bulbous downgrowths some resulting from the filling of gland spaces. An appearance which might be mistaken for malignancy

In examining large numbers of sections one is frequently struck by the fact that an inflammatory reaction of a density<sup>1</sup> which is always sufficient to call forth strong reactive changes in connection with squamous epithelium effects no reaction when in contact with the normally situated original columnar epithelium. Figure 21 again shows the junction between the squamous and columnar epithelia. There is a subepithelial inflammatory reaction present which has had the effect of thickening the squamous epithelium (by the process already discussed) but has had no effect upon the high columnar cells which maintain their evenness of continuity.

This distinction in reactive qualities between these two types of epithelium is not so obvious in a section such as this which shows the two in contact as it is in others where the effect of the same irritant can be observed, but in different areas. We shall however, meet with such instances later. My object however in this section is to show the great distinction in stability or resistance to irritation that exists between these two types of epithelium. It will be seen throughout that an irritant the action of which will produce destruction of the squamous epithelium will only produce a proliferative reaction in the columnar epithelium of the canal and glands.

<sup>1</sup> And later discuss the question suggested by this term

and that one which can produce proliferative changes in the squamous epithelium has no effect upon the columnar. The distinction goes much further than this, as we shall see, but thus far we are able to exemplify these two dissimilarities which will suffice in the attainment of the object in view.

In dealing with a structure one cell in thickness the relationship in age of the cells does not enter as it did when dealing with the squamous epithelium, but the function of these columnar cells is obviously that of a



Fig 29 The more regular and shorter downgrowths associated with transient erosion



Fig. 25. Old squamous epithelium affected by an irritant of the first degree of virulence from below—being an increase from an irritant of the second degree. Dense acute inflammatory infiltration in contact with terminations of downgrowth.



Fig. 26. Local destruction without cell reaction of terminal portion of cell downgrowth. Basal epithelial activity is present in the superficial rarefied zone. Columnar cell division is well shown.

in shape. This fact is in accordance with what we have seen when the basal cells react to irritation. When actively functioning they temporarily lose their definite columnar quality—a fact which is easily understood when one realizes that the cell function necessitates cell division. I therefore believe that during the process of repair in old erosions the new squamous epithelium is produced by the active physiological activity of these primary basal cells and not by direct growth extension from adjoining squamous cells. Indeed as I have said before I consider these cells to be physiologically inert having owed their inception to the basal cells themselves and being capable only of direct proliferation under stimulus as behooves cells the function of which is a purely mechanical one.

The question of the age function and stability of the elements of the squamous epithelium is now complete but we must still consider in this section the same factors with regard to the columnar cells which line the cervical canal and glands. These cells differ morphologically from those just discussed in that they are of the high columnar type possessing well marked nuclei at the base and are ciliated. Normally their junction with the squamous epithelium in the region of the external os is abrupt and serial sections of

this region fail to show any definite continuity between them and the basal columnar cells of the squamous layer.

Figure 20 shows this normal junction. At its termination the squamous epithelium tapers either abruptly or gradually the basal columnar layer growing upward to meet a descending surface. The columnar cells of the canal join this termination abruptly, and there is no impression of continuance between them and adjoining cells.

We have already seen in discussing the pathology of erosion that the columnar epithelium is the most resistant to infection and irritation. This is exemplified by the fact that this epithelium is the first to proliferate to the surface of the affected area, which it covers while still proliferating in the primary effort to effect repair (see Fig. 4). These cells are thus in actual contact with an irritant the virulence of which is sufficient utterly to destroy the original squamous epithelium *en masse*. We have seen moreover that it is not until this virulence is considerably diminished that the basal layer of the squamous epithelium again grows out on to the surface held by the columnar epithelium (see Fig. 6). The columnar epithelium, therefore is much more resistant to maceration and hence more stable than any of the elements of the squamous epithelium.



Fig. 27 Long bulbous downgrowths resulting from continued irritation of the squamous epithelium from below by an irritant of the third degree of virulence

In examining large numbers of sections one is frequently struck by the fact that an inflammatory reaction of a density which is always sufficient to call forth strong reactive changes in connection with squamous epithelium, effects no reaction when in contact with the normally situated original columnar epithelium. Figure 21 again shows the junction between the squamous and columnar epithelia. There is a subepithelial inflammatory reaction present which has had the effect of thickening the squamous epithelium (by the process already discussed) but has had no effect upon the high columnar cells which maintain their evenness of continuity.

This distinction in reactive qualities between these two types of epithelium is not so obvious in a section such as this which shows the two in contact as it is in others where the effect of the same irritant can be observed, but in different areas. We shall however, meet with such instances later. My object however, in this section is to show the great distinction in stability or resistance to irritation that exists between these two types of epithelium. It will be seen throughout that an irritant the action of which will produce destruction of the squamous epithelium will only produce a proliferative reaction in the columnar epithelium of the canal and glands,

I shall later discuss the question suggested by this to me



Fig. 28 Large irregular bulbous downgrowths some resulting from the filling of gland spaces. An appearance which might be mistaken for malignancy

and that one which can produce proliferative changes in the squamous epithelium has no effect upon the columnar. The distinction goes much further than this as we shall see, but thus far we are able to exemplify these two dissimilarities which will suffice in the attainment of the object in view.

In dealing with a structure one cell in thickness the relationship in age of the cells does not enter, as it did when dealing with the squamous epithelium but the function of these columnar cells is obviously that of a



Fig. 29 The more regular and shorter downgrowths associated with transient erosion



Fig. 30 Squamous downgrowth filling a gland space. New cell production laterally and old cells forced downward.

secreting epithelium, so that in all cases in which this epithelium is stimulated to the extent of proliferation, its resultant activity is always toward the formation of new glands. This we have seen to be the case when dealing with erosion.

We shall now proceed to consider the reactive changes produced in these various epithelial elements in response to the irritative stimulus, and to that end one must recognize the fact that cellular reactions will depend upon the strength or virulence of the par-



Fig. 32 The effect of an irritant of the third degree upon long standing proliferated epithelium.



Fig. 31 A pseudo appearance of early malignancy produced by irregular bulbous downgrowths.

ticular stimulus to which they are subjected. A brief consideration of this factor must, therefore, take precedence.

#### THE RELATIVE VIRULENCE OF IRRITATIVE STIMULI AFFECTING CERVICAL EPITHELIUM

During the histological examination of a large number of specimens, as in this series one is constantly confronted with the fact that the irritative stimulus in contact with the epithelium, which is evidenced by the production of an inflammatory reaction in the vicinity, falls for practical purposes that is according to the specific cellular reaction which results into five main degrees. The first may be called irritative stimuli of the first, second, third, fourth and fifth degree of virulence in descending order. One may safely presume that the typical inflammatory reaction which is produced in living tissues in response to the presence in them of foreign bodies, atypical cell formations (tumors), chemical irritants or infections by microorganisms varies in density directly as the degree of irritation produced by these intruders. Without going so far as to make an actual comparison by cell count of the leucocytic and lymphocytic cells in affected areas under consideration it has been quite obvious during the routine study of the 8,500 cases of my series, that from the point of



Fig 33 General bulbous downgrowths

view of cellular density in the inflammatory infiltration produced, the tissues under consideration have been subjected to irritations (no matter from what cause) which may be divided into five main degrees of virulence, and it is a fact that the resultant epithelial reactions correspond to a great degree of accuracy with the density of the infiltration which is in immediate contact.

One recognizes, of course, the fact that the reaction on the part of the tissues of the body, which is itself the instigator of these histological evidences, is governed by the resistance of these tissues to invading irritants—and hence is necessarily a varied factor even as the actual degree of irritation is varied. The action of an irritant of known virulence upon the tissues of one particular person will result in the production of an inflammatory reaction of a density differing from that produced by the same irritant in another host. These reactions would, of course, be regulated by the affected persons' powers of resistance, and histologically the cellular densities of the associated inflammatory reactions will differ in the two cases in either one of the innumerable (presumably) minor degrees, or even sufficiently to warrant placing this known irritant in separate main categories of virulence in each case such as has been described. It will thus be seen that, owing to the presence of the varied factor of



Fig 34 Irregular small epithelial nodules produced as the result of a round cell infiltration of the fourth degree. A local infiltrative concentration can be seen. No sub-epithelial rarefaction. Narrow zone of newly produced cells.

the patient's resistance, it is compatible with sound reasoning to suppose that a given irritant may produce tissue reactions in different hosts, the histological examination of which would place that irritant in different main categories of virulence. The five degrees of virulence therefore, into which I have divided the irritants affecting cervical epithelium are purely relative—relative to the



Fig 35 Uniform epithelial thickening in response to an irritant of the fifth degree of virulence. The columnar nature of the basal layer is well seen. A loose epithelial lymphocytic infiltration.



Fig. 36 High power view to show the definite columnar character of the basal layer and the process of cell production from this by metaplasia



Fig. 37 General view of the effect of an irritant of the third degree of virulence upon new squamous epithelium (see The Cancer Phase—Squamous Epithelium)

resistance of the host. Theoretically each degree might be produced by the same irritant. Again any one degree might be produced by irritants varying in actual virulence. I have said above however that the effect of these five degrees of irritant upon the affected epithelial structures is constant to a high degree of accuracy as nearly as one can

speak of constancy in connection with the human subject and without absolute mathematical accuracy of detail.

We have therefore two varying factors (1) the actual virulence of the irritant and (2) the host's resistance combining to the production of a definite histological phenomenon which I will treat as a constant factor, on account of the constant effect produced by it—an inflammatory reaction of either of five cellular densities—to which a relative term in irritative virulence is applied indicative of the relationship of the varying factors mentioned and these relative degrees of irritation have a constant effect upon cervical epithelium.

To complete this chain as it were it would appear that one must expect the individual cells of cervical epithelium to react constantly to minute variations in the degree of irritative stimulus and therefore to maintain themselves as constant factors in the scheme. Whether this be so it is of course impossible to say but in any case the absolute constancy of this terminal factor is not a necessity in so much as their type of reaction to irritation is histologically uniform and as the main degrees of irritative virulence are alone able to effect the important and constant distinctions in cellular change one may safely presume that the included minor degrees are similarly uniformly reacted to.



Fig. 38 The cancer phase—squamous epithelium. The earliest evidence of the inception of cancer change. Perforation of the basal layer by inflammatory exudate. A typical cell proliferation on the part of the new peripheral cell. Typical blurring of general cell mass (see text). The spasmodic and localized metaplastic response on the part of the basal layer.



Fig. 39. Destruction of the new squamous epithelium without reaction by contact with a localized increased density of the subepithelial infiltration corresponding to the first degree of virulence (see Figs. 27 and 23)

While recognizing, therefore, that the degrees of density of inflammatory reaction in the human body are infinite, I have preferred here to divide them into five main degrees on account of the fact that cellular reactions as I have observed them throughout the whole of my series, fall into five main types and these correspond accurately to the main degree of irritation in contact

#### THE EFFECT OF THE ACTION OF AN IRRITANT OF THE FIRST DEGREE OF VIRULENCE UPON OLD SQUAMOUS EPITHELIUM

The picture here is one of complete and rapid destruction of the epithelial elements. The densest type of inflammatory reaction consisting of masses of closely packed leucocytes and lymphocytes envelopes the remains of the epithelial cells in the affected area. Destruction by maceration and liquefaction is carried out, without any effort to respond on the part of the epithelium. This type of reaction takes place in Stage 1 of so called cervical erosion. An acute irritant is in contact with an unprepared epithelium. Rapid destruction results. Among the masses of infiltrated leucocytes one may observe numerous areas of partially destroyed cells of the polyhedral type formally belonging to the deeper layers of the squamous epithelium



Fig. 40. The cancer phase—squamous epithelium somewhat farther advanced stage (see text)

The infiltration penetrates relatively deeply from the affected surface, and quantities of dislodged squamous cells come to occupy positions at a much deeper level than they did originally since they are carried inward by the fluid exudate excited by the irritant. They are, however, at this stage partially destroyed and totally inert.

Figure 22 shows the type of density of the inflammatory reaction associated with an irritant of the first virulence and the depth to which the infiltration penetrates relative to the pre existing epithelium

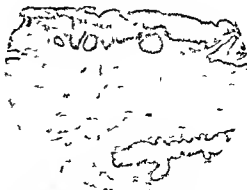


Fig. 41. The cancer phase—squamous epithelium. Another instance (see text)



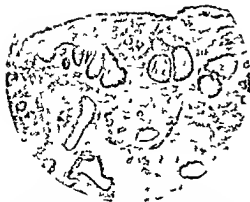


Fig. 42 The cancer phase—squamous epithelium. A more advanced phase bordering upon developed cancer

One may observe in such a case that the epithelium adjacent to the affected zone shows only slight reaction. There is but a slight increase in its thickness showing that there has been no long continued action of the irritant upon it. What reaction there is, since such action is due to the increased production of new polyhedral cells by the stimulated basal layer and these are plainly visible, corresponds accurately to that expected when this layer is in contact with the looser inflammatory infiltration, which is here observed as a prolongation from the main mass. There has been no time for epithelial reaction to take place to any extent



Fig. 44 High power view

along this lesser involved line. The transition between the denser infiltrative zone, in which the epithelial elements are destroyed and the relatively unaffected areas is abrupt. That the squamous epithelium here has as yet been unaffected by previous irritants is shown by its total thinness, the relative scarcity of polyhedral cells, and thickness of its superficial flattened layers, combined with the lack of subepithelial rarefaction, a legacy of previous erosion. The density of the subepithelial tissues here is such that the cells of the basal layer of the epithelium are largely cuboidal in type. There is also no evidence here of old cervical glandular proliferation. We are dealing, therefore, with the effect of the most virulent irritant upon old, original, squamous epithelium, the composing cells of which should possess the highest degree of resistance to maceration possible to this type of cell.

At the very point of contact however, between the denser inflammatory infiltration and the adjacent epithelium the basal columnar layer is broken through and inflammatory cells infiltrate to some extent between the squamous cells. There is no reaction on the part of the superficial epithelial cells which are inert and purely protective. The lower polyhedral cells show abortive attempts at proliferation but the irritant is too strong and its action too rapid at this site to allow



Fig. 43 A very early developed squamous cancer (see text)



Fig. 43. The slight cellular reaction produced in glandular epithelium by contact with an irritant of the first degree of virulence

resistance and local destruction is again observed here

Figure 23 shows this area, which is of course, common to all this type of case. Inflammatory infiltration into the substance of the squamous layers can be seen and the ruptured basal columnar layer is easily discernible. The lack of epithelial reaction to the irritant is definite. In this section one may also observe the isolated areas of half destroyed squamous cells at various levels in the densest part of the exudate. These cells are changed and varied in shape but tend to cling together for the most part in small groups.

Such is the effect, therefore, of an irritant of the first degree of virulence upon squamous epithelium. The picture is one of total and rapid destruction, and the cellular reactions conform in detail to this process. The reactions here described are observed in the first stage of so called cervical erosion. In this condition the full effect of the irritant is relatively transient. The resistance of the affected tissues is such that the process of cell destruction is soon stayed and the phenomenon of repair commenced. The adjacent epithelial structures, therefore, undergo little or no reactive change but constitute the basis from which the ultimate repair cells emanate as previously described.



Fig. 46. The cancer phase—columnar epithelium. The cell reactions immediately preceding malignant change in young gland epithelium (see text)

#### THE EFFECT OF THE ACTION OF AN IRRITANT OF THE SECOND DEGREE OF VIRULENCE UPON OLD SQUAMOUS EPITHELIUM

The cellular reactions involved in this instance are observed in cases of true active ulceration of the cervix. The base of the ulcer consists of squamous epithelial elements destroyed by maceration in consequence of their contact with an irritant of the first degree of virulence. In the case of true ulceration the resistance of the tissues is



Fig. 44. The cancer phase—columnar epithelium. A slightly more advanced stage. The earliest evidence of definite cancer change in new gland epithelium



Fig. 48. Direct malignant proliferation from old gland elements in response to local and prolonged severe irritation

relatively poor. The process of invasion of the destructive irritant is inadequately stayed. The phenomenon of ultimate repair is delayed. The result is therefore, that the zone of destruction is more permanent and pending the advent of the repair it becomes gradually transformed, by organization of the inflammatory elements into one of chronicity, its composition being chiefly that of granulomatous tissue in which are embedded scattered areas of semi liquefied polyhedral cells remnants of the primarily affected squamous lining which are carried far down into the depths by the destructive exudates.

Meanwhile the adjacent squamous lining is in contact with an inflammatory infiltration of a density distinct from that just discussed yet possessing equal activity since polymorphonuclear leucocytes are present in relatively equal quantity. The area now under consideration is, of course the extreme edge of a zone of acute inflammation the area at which tissue resistance is attempting to assert itself, or at which there is a falling off in the full force of the irritant. Irritation of the second degree, therefore is a transient



Fig. 49. Advanced cancer. The contact between the benign and malignant tissues can be observed

and relatively rapid phase between the destructive and milder types and its action upon old squamous epithelium is observed only in connection with the active stage of true ulceration. It is the degree of non destructive but most irritative type and is characterized by a typical reaction on the part of epithelial cells in contact with it. At either edge of a most active ulcer, the under surface of the adjacent squamous epithelium is in contact for a short distance with an inflammatory infiltration, of the same active nature as that which has destroyed a section of it, but of a density approximating to about one third. The cellular reaction in this region is most intense. The basal columnar layer is irritated to such an extent that its most active degree of metaplastic activity is called forth. Long sharp pointed downgrowths are quickly produced as the result. The central cells of these downgrowths are of the new polyhedral type (as previously described) resulting from division of the basal columnar cells but the cells lining the sides are of the low cuboidal or columnar type true basal cells. It is at the extreme point of the downgrowth that the greatest activity exists and here a small localized bulging may be brought about. The columnar cells can here be seen in the state of active division newly separated cells being extruded upward to the interior of the downgrowth. The true columnar character of these basal cells can well be made out in most cases, but such is

their activity at this region that the height of the lowermost cells is often considerably diminished. The transition from the columnar to the polyhedral type is well observed in the recently produced cells as they recede farther from the base. The tremendous activity of these basal cells acts as a protection to the central cells. Even in contact with this degree of irritation, the basal layer remains functionally intact. In the most irritated cell downgrowths a small abrasion of this layer may occasionally occur, with local cell destruction beneath, but that the external irritant does not tolerate irritative reaction on the part of the central cells, is shown by their lack of, or negligible, proliferation. Such a breach in this protective and functional layer is but a momentary in the case of epithelium, the reactive powers of which are capable, if only just, of combating the irritation inflicted upon them. This is so in the instance under consideration. In such a case the more acute stage of ulceration will be overcome and the condition will pass into chronicity and thence to healing.

Figure 24 shows the phenomenon here described. The type of cervix subject to ulceration is one that has undergone some previous hypertrophy. The squamous covering in this case is already thickened by the slow process of cell production under the lowest grade of irritative stimulus. The epithelial cells as a whole, however, may be said to be relatively old (although not as old as those comprising the original covering) on account of the extreme slowness with which this thickening has taken place and the length of time which it has been present. These facts are proved by the relative thickness of the superficial flattened cells of the stratum corneum, and the relative paucity of recently produced cells in the malpighian layer, which is almost entirely composed of vacuolated cells of the long standing type. The squamous covering shown in Figure 24, therefore, is of the type common in long standing hypertrophy. The basal columnar cells, therefore, are now functionally old cells. There is now no subepithelial rarefaction. Fibromuscular elements about on to the epithelial. Regenerative vitality must have

been acquired as the result of long continued rest. This type of epithelium then must be considered old.

It will be seen when old epithelium is in contact with an irritant, such as in this case, that the dense subepithelial fibromuscular tissues exert a protective effect of their own. The inflammatory cell exudate can be seen to occupy positions between the muscle bundles, which themselves serve as a partial barrier between this and the epithelium. There is obviously much greater difficulty in the irritant making contact with epithelial cells which are closely supported by dense mesoblastic structures than with those unprotected in this respect.

I consider that the importance of the cell reactions involved by contact with this grade of irritant lies more in the remote effect produced than in the immediate one. The immediate effect shows a great tribute to the manifold activities of the cells of the basal layer. The complete reaction is quite distinct from anything else seen in epithelial activity, and it is for this reason that I have nominated the causal agent to a degree of virulence of its own, namely, the second degree. The reaction is, however, a definitely localized one and, notwithstanding the angry nature of it, is not one of immediate danger, from the point of view of malignancy. This is the most rapidly produced epithelial reaction possible. The thinner and more pointed the downgrowths, the more rapidly they have grown, the greater the proportion of proliferative to metaplastic activity on the part of the basal layer. There is no danger of malignancy at this stage. If a point is reached at which the basal cells fail temporarily or permanently in their function, a breach is made in this layer and the central cells are locally destroyed. There is little or no reaction on their part. The irritant in contact is of too active a nature to permit of irritative proliferation in cells of the passive type. The importance of this phase lies in its remote effect. The most active new cell production is combined with an extensive subepithelial rarefaction. At the close of this phase, one is left with the most highly sensitive epithelium possible, composed both in the basal and

other layers of very young cells and totally unprotected from below by supporting mesoblastic structures

The effects of irritants of the first, second, and third degree of virulence upon old epithelium are the effects of different degrees of the same type of inflammatory reaction namely, acute inflammation as evidenced by the polymorphonuclear character of the exudate. The three degrees differ only in the density of the infiltration. The three reactions are distinct. The type of irritant is, however, the same and its function, in sufficient concentration, is to destroy epithelium. Thus it does in the first degree but not in the second or third. An irritant of the first degree nearly always attacks the epithelium from the surface aspect and it is as one of the second degree that its effect upon subepithelial contact is observed, thus resulting in the reaction just described. However, proof of the consequent destruction which would result from an increase in the virulence of a subepithelial irritant is shown by a study of Figure 25. According to my series, this is the rare condition in which an acute inflammatory exudate corresponding to the density of the first degrees of virulence is in contact with the squamous epithelium from below and along a wide area. The old nature of the epithelium can be observed as well as the strength of the deep supporting tissues. There is rarefaction, however in the more superficial zones. The inflammatory infiltration is extremely dense and highly polymorphonuclear. It is obvious here that the cell reaction similar to that provoked by an irritant of the second degree has taken place, leaving rarefied areas between the downgrowths, and that the irritant has then increased in virulence to the first degree, either by addition to it or by diminution of the patient's resistance at this stage. The types of the cell downgrowths are now densely involved in inflammatory exudate the elements of which can be seen to have penetrated through the basal cell layer into the substance of the central cells themselves. The muscular supporting elements in this region are, however quite in evidence, but are not capable of adequate protection against

this irritant. The terminal portions of the cell downgrowths are seen to be undergoing destruction by liquefaction. There is little or no irritative proliferative reaction on the part of the passive cells. Higher up in the rarefied areas, where the infiltration in contact is relatively slight, there are local metaplastic and proliferative reactions of a typical nature on the part of the basal columnar cells involved. The true destructive effect of an acute inflammatory infiltration is demonstrated here. There is no time for pure cell proliferation. Presumably the liquefactive properties of the polymorphonuclear leucocytes take effect too quickly. The very acuteness of the inflammatory reaction is a safeguard against malignancy, so long as the acuteness lasts. As I have said above, irritants of the first, second, and third degrees of virulence belong to this type.

#### THE EFFECT OF THE ACTION OF AN IRRITANT OF THE THIRD DEGREE OF VIRULENCE UPON OLD SQUAMOUS EPITHELIUM

*The production of bulbous downgrowths*  
Without doubt the most common of the cell reactions observed in connection with epithelial irritation affecting the squamous layer is that produced by irritants of the third degree of virulence. It is the reaction typically resulting from the effects of an irritant of moderate strength acting over a longer period than those just discussed. It is to be found in the regions more remote from the zone of acute destruction in so called erosions and commonly as a phase during the stages of healing. It is also seen in the more chronic or less active type of ulceration. The bulbous or blunt epithelial downgrowth is the direct outcome of the effects of an irritant insufficient to cause destruction, but of sufficient strength to stimulate the basal layer to active metaplastic and proliferative activity of a slower and more uniform nature than that observed in the case of the second degree. The rate at which cell activity is called for is such as to enable the cells of the basal columnar layer to react more constantly and, as a rule, in degrees varying directly as their distance from the apex of the downgrowth which point owes its position to a localized

increased concentration of the inflammatory reaction concerned. The infiltration produced by this particular degree of irritation is of a density distinct from that of those already discussed and approximates to half that of the second degree.

In the case of the third degree, however, a certain latitude is allowable as to the actual density of the infiltration, and the bulbous downgrowths produced vary somewhat in the degree of bluntness directly as the degree of this density. This variation, however, in no wise detracts from the definite character of the third degree as a whole, as evinced by the specific cell reactions called forth by its action. It is also distinct in every way from the preceding and proceeding degrees of irritation.

The inflammatory infiltration in question is produced on the outer zone of a focus of acute inflammation. A point is reached at which the infiltration is reduced to a stage of easy tolerance on the part of the tissues in contact with it. This process is of course gradual, the diminution in the density occurring uniformly in conjunction with the distance from the central focus. After the zone occupied by the second degree is passed, however, the irritant no longer possesses the power of destruction, and from that point down to one at which the acuteness of the reaction may be said to cease, a typical cell response is produced resulting in the formation of bulbous downgrowths, as aforementioned, which differ only in their length and bluntness according to the slight variations in the density of the infiltration which has been in contact.

Figure 27 shows an example of the more active type of bulbous downgrowth. This type, of course, is found in connection with the outer zones of active ulceration or nearer to the central zone in the case of the more chronic ulcers or healing ulcers.

It is a fact, as is natural to suppose, that the long bulbous downgrowth does not occur in connection with acute erosion as the process is far too transient to allow of their production.

A long continued irritation in contact with the basal layer of the epithelium is necessary

to the production of this type, and this can be affected only in conjunction with true ulceration (Cf ulcers).

In Figure 27 this condition may be observed. The original squamous layer shows a condition of long standing hypertrophy. The relatively newly produced cells stain more deeply in the region of the base of the downgrowths. As they recede to the surface, the nuclear staining becomes fainter until it is gradually lost as they approach the surface. New cell production is seen to be carried out at the sides of the downgrowths in the same way, but not to quite the same extent, so that the bulbous shape is thus maintained. The depth of the newly produced cells is relatively slight, as compared with the mass of old ones, thus demonstrating the slowness of the general reaction. The inflammatory infiltration is observed to be uniform but mild as compared with that observed in the preceding degrees. Exudative cells are seen in contact with the downgrowths both at the sides and bases, and it is obvious that the relative rate of cell production by the basal layer varies as the density of the infiltration in contact. The subjacent fibromuscular elements are observed in normal density and are acting as a partial protective agent to the epithelial cells, as previously described. Of course, these bulbous downgrowths may assume great relative size, varying with the length of irritation experienced and the degree of resistance of the subjacent tissues. A large bulbous downgrowth, for instance, is likely to result from active epithelium situated at the mouth of a cervical gland. The new cells easily fill the gland lumen. Figure 28 shows an example of this. But, in all, the process is the same—that of steady, uniform, polyhedral cell production by metaplastic activity of the basal layer, combined in addition with constant proliferative activity on the part of these same cells.

The bulbous downgrowths seen in connection with transient erosions are generally of a more uniform type and smaller. They are the result of a much less prolonged irritation. Figure 29 gives a fair example of this type. In this figure the columnar character of the basal layer is well shown. The newly formed

polyhedral cells can also be seen being extruded toward the epithelial surface. The regular subepithelial infiltration is well observed.

Figure 30 shows another example of squamous cells in process of filling a proliferated gland space. It will be seen that the production of cells is from the sides of the downgrowths, which are in contact with the irritant, and that old polyhedral cells are being forced down by pressure into the gland lumen. There is no cell activity at the base of such a downgrowth.

Numerous examples of bulbous downgrowths may be observed in connection with inflammatory conditions of the cervix. The foregoing are typical examples. The depth of the downgrowth varies as the length of the irritation and the degree of resistance by subjacent tissues. The longest downgrowths are, therefore, observed in connection with the outer zone in chronic ulceration and in cases in which the cells are placed within a gland lumen which contains an inflammatory exudate. In certain cases the irregular shape of the downgrowths, together with artefact in preparation, give a pseudo appearance of early malignancy. Figure 31 shows an example of this. A few irregularly shaped downgrowths, with small areas apparently separated owing to prolongations having been cut across, present an appearance which might be mistaken for commencing malignancy by anyone not accustomed to gynecological pathology.

In all this type of case, however, it will be seen that an acute inflammatory exudate of a certain maximum density, approximating to half that observed in the second degree, is in contact with the basal layer, that new cell production takes place from this layer on all sides of the downgrowth, and that the rate of production varies directly as the local density of the general infiltration. The fact is evident, however, that the rate of new cell production called for by this third degree of irritation is not too fast to be conveniently dealt with by the metaplastic and proliferative powers of the basal layer of cells. In no area does one find a rupture of this layer with destruction of the polyhedral cells beneath. Here and there

along the edge of the downgrowth, localized increased activity is seen, but this is accompanied by adequate replacement by the basal layer, and a new bulging prolongation results. The type of cell reaction to this degree of irritant is definite. Whenever a looser subepithelial infiltration of the same nature is observed, it is merely a transient prolongation from one of this degree, and as such is not responsible for any specific reaction.

Figure 32 shows very well the effect of this degree of irritant upon an old, thickened epithelium. The squamous covering here has long ago passed through proliferative activity, so much so that its entire thickness is practically made up of vacuolated cells possessing little or no cytoplasm. In these cases of long standing hypertrophy, as before mentioned, one looks upon the epithelium concerned as relatively old.

An irritation supervenes here and one can observe the zones of newly formed polyhedral cells standing out by contrast of their cytoplasmic contents from the old squamous cells. The basal cell activity and subepithelial infiltration are well shown. The general reaction results in the production of irregular bulbous downgrowths.

Figure 33 again shows a good example of the bulbous type of downgrowth extending over a wide area.

With a consideration of the third degree of irritation, we conclude the question of the effect of acute inflammatory infiltrations upon old squamous epithelium. I find that the effect of the purely chronic type of inflammatory reaction falls into two closely approximated types, which nevertheless might be distinguished on account of a difference in density. The first or more virulent of these we will now consider under the heading of the fourth degree.

#### THE EFFECT OF THE ACTION OF AN IRRITANT OF THE FOURTH DEGREE OF VIRULENCE UPON OLD SQUAMOUS EPITHELIUM

*Chronic inflammation.* The purely chronic type of inflammatory subepithelial exudate is comparatively rare. There is no doubt that in my series this particular reaction occurs only once, approximately to every thirty

examples of the acute variety. The cell reaction produced is negligible. There is very little irritative quality associated with a pure round cell infiltration. This type, however, is worthy of note on account of the well known pathological regard for "chronic inflammation" and "chronic irritation." These, of course, are terms loosely applied to inflammation and irritation of long standing and do not necessarily apply to this exact type, which, as we shall see in connection with the cervix uteri at any rate, is a factor of relatively little importance.

Pathologically the effects of the purely chronic form of irritation, as evinced by the presence of a purely round cell subepithelial infiltration, are small in comparison with those just discussed. They should, however, be divided into two degrees according to virulence. The denser form, that which forms the subject of this chapter, is observed as a fairly regular infiltration in contact with the basal layer of the epithelial covering, having a density less than that associated with the active infiltration of the third degree, but possessing irregularly scattered nodes of concentration, similar to the lymphatic nodes observed in cases of leucoplakia vulvæ.

I do not consider these to be of the same nature inasmuch as they are more intimately connected, as a rule, with the general infiltration. I regard them nevertheless as an evidence of the relative virulence of this type of irritation, such as it is, and estimate that a reaction of this character possesses an irritative power only one stage less than that described as the third degree.

The typical reaction observed is distinct from all others in so far as the general cell activity is concerned. The epithelial response is limited and stunted. The mesoblastic tissues show little or no change. The basal columnar cells react to the irritant irregularly and to a relatively limited degree. Irregular, short, and scattered cell downgrowths are produced. Small nodular protruberances form the epithelial base rather than downgrowths. The slowness with which they are produced is evidenced by the fact that the cytoplasmic staining faculty of the more recently formed

polyhedral cells differs but slightly from that of the older cells in the epithelium, and that the number of newly formed cells, even in respect of the areas of downgrowth, is small, a fact which is demonstrated by the relative narrowness of the more deeply staining zone of new cells.

Where the infiltration is somewhat diminished, an irregularly diffuse thickening of the epithelium is produced by more regular basal cell activity. The fibromuscular elements remain practically unchanged. There is no rarefaction.

Figure 34 shows this reaction and indicates the position of a localized area of concentration in the infiltration.

The epithelial reaction here agrees in detail with what one would theoretically expect by a comparison with the effect of an irritant of the third degree. There is no doubt that the squamous epithelium behaves uniformly toward external stimuli. This uniformity of behavior is a constant factor throughout. The squamous epithelium itself holds no secret.

#### THE EFFECT OF THE ACTION OF AN IRRITANT OF THE FIFTH DEGREE OF VIRULENCE UPON OLD SQUAMOUS EPITHELIUM

The irritant of the fifth degree is the mildest possible one and is represented by the presence of a loose, round cell infiltration in contact with the basal layer of the epithelium, of a density approximating to one half of that associated with the fourth degree.

As might be expected from the uniform and slight nature of the stimulus (there are no associated points of concentration of the infiltration), the epithelial reaction is also uniform, or nearly so, and this takes the form of a generalized thickening by new cell production from the basal layer. There are no localized cell downgrowths here because the irritant never reaches a sufficient concentration to force their production. However, wherever the density is slightly increased, one may readily observe a corresponding slight increase in the general epithelial thickness, another tribute to the extreme uniformity of the epithelial behavior. It is certainly in these lowest grades of irritation that one may



polyhedral cells can also be seen being extruded toward the epithelial surface. The regular subepithelial infiltration is well observed.

Figure 30 shows another example of squamous cells in process of filling a proliferated gland space. It will be seen that the production of cells is from the sides of the downgrowths, which are in contact with the irritant, and that old polyhedral cells are being forced down by pressure into the gland lumen. There is no cell activity at the base of such a downgrowth.

Numerous examples of bulbous downgrowths may be observed in connection with inflammatory conditions of the cervix. The foregoing are typical examples. The depth of the downgrowth varies as the length of the irritation and the degree of resistance by subjacent tissues. The longest downgrowths are, therefore, observed in connection with the outer zone in chronic ulceration and in cases in which the cells are placed within a gland lumen which contains an inflammatory exudate. In certain cases the irregular shape of the downgrowths, together with artefact in preparation, give a pseudo appearance of early malignancy. Figure 31 shows an example of this. A few irregularly shaped downgrowths, with small areas apparently separated owing to prolongations having been cut across, present an appearance which might be mistaken for commencing malignancy by anyone not accustomed to gynecological pathology.

In all this type of case, however, it will be seen that an acute inflammatory exudate of a certain maximum density, approximating to half that observed in the second degree, is in contact with the basal layer, that new cell production takes place from this layer on all sides of the downgrowth, and that the rate of production varies directly as the local density of the general infiltration. The fact is evident, however, that the rate of new cell production called for by this third degree of irritation is not too fast to be conveniently dealt with by the metaplastic and proliferative powers of the basal layer of cells. In no area does one find a rupture of this layer with destruction of the polyhedral cells beneath. Here and there

along the edge of the downgrowth, localized increased activity is seen, but this is accompanied by adequate replacement by the basal layer, and a new bulging prolongation results. The type of cell reaction to this degree of irritant is definite. Whenever a looser subepithelial infiltration of the same nature is observed, it is merely a transient prolongation from one of this degree, and as such is not responsible for any specific reaction.

Figure 32 shows very well the effect of this degree of irritant upon an old thickened epithelium. The squamous covering here has long ago passed through proliferative activity, so much so that its entire thickness is practically made up of vacuolated cells possessing little or no cytoplasm. In these cases of long standing hypertrophy, as before mentioned, one looks upon the epithelium concerned as relatively old.

An irritation supervenes here and one can observe the zones of newly formed polyhedral cells standing out by contrast of their cytoplasmic contents from the old squamous cells. The basal cell activity and subepithelial infiltration are well shown. The general reaction results in the production of irregular bulbous downgrowths.

Figure 33 again shows a good example of the bulbous type of downgrowth extending over a wide area.

With a consideration of the third degree of irritation, we conclude the question of the effect of acute inflammatory infiltrations upon old squamous epithelium. I find that the effect of the purely chronic type of inflammatory reaction falls into two closely approximated types, which nevertheless might be distinguished on account of a difference in density. The first, or more virulent of these, we will now consider under the heading of the fourth degree.

#### THE EFFECT OF THE ACTION OF AN IRRITANT OF THE FOURTH DEGREE OF VIRULENCE UPON OLD SQUAMOUS EPITHELIUM

*Chronic inflammation.* The purely chronic type of inflammatory subepithelial exudate is comparatively rare. There is no doubt that in my series this particular reaction occurs only once, approximately to every thirty

between old squamous epithelium and that which has been recently formed as the result of the reparative mechanism in dealing with the damage caused by cervicitis. The new squamous covering is always found, therefore, in conjunction with evidences of the end results of cervicitis: proliferation of the cervical glands in the region of the external os, distended gland spaces in this situation, and a certain amount of rarefaction of the subjacent mesoblastic tissues. The new epithelium itself is often fairly uniform in thickness. The cells composing it are very much more uniform in their staining properties than those concerned in old squamous epithelium. As a result the basal columnar layer is not so prominent, and in addition the cells comprising it are a little more inclined to the cuboidal on account of their recent productive activity. The nuclei of even the surface cells are still obvious, there being a relatively narrow layer of the more flattened type and these but partially flattened as yet. The entire cell content of this recently formed structure is young. The diffuse and deep cytoplasmic staining together with the large size of the cell nuclei indicate this fact. The newly produced polyhedral cells are of necessity highly unstable, not far removed from the embryonic at this stage. Until they have enjoyed immunity from external irritation for a certain minimum period as the result of complete protection by the basal layer which produced them, they will not acquire that histological proof of stability indicated by the gradual loss of cytoplasmic staining and the diminution in the size of the nucleus which is observed in their older counterpart and which is known to be the associate of complete passivity both in function and in responsiveness. These new cells have the same passive rôle to play if they are allowed to grow old enough to play it. The cells of the superficial zone are nucleated, having been rapidly extruded to the surface in the manufacture of the new covering. The basal columnar cells must necessarily be relatively unstable as such, having been called upon to exert their full metaplastic function in this production. As pure protecting cells they cannot be com-

pared with the basal cell layer seen in old and hitherto unaffected epithelium nor even that associated with a diffusely (and hence slowly) thickened epithelium resulting from the effects of low grade irritation. In these latter cases we have seen how the basal layer reacts to the varying degrees of external stimulus, but in the case of newly produced epithelium the complete destruction of this layer is much more easily accomplished, and even the destruction of the new epithelium itself. As I have said elsewhere, however, destruction of epithelium is a safeguard against malignancy. Irritation of epithelium short of the power to destroy is the danger, and especially is this the case where the young cell is the one affected, and more especially still when that young cell plays a purely passive rôle functionally and can react to stimulation only by active proliferation. If that young cell were allowed to age only sufficiently to lose the active elements of its protoplasmic and nuclear contents, as evinced by the deep diffuse staining properties of these constituents, and to pass into its functional and responsive inactivity, the resultant reaction to external irritation would be nil or practically so as shown by the effect of destructive irritants upon old squamous epithelia. In all our previous inquiry the basal layer has either been in a position adequately to protect its inactive progeny or this has been destroyed with little or no reaction along with the basal layer.

In a word, there are only two conditions under which an irritant can exert prolonged action upon the polyhedral cells of squamous epithelium without being strong enough to destroy them. In every other case the basal cell layer is strong enough to protect them by metaplastic activity. Penetration of this layer by destruction results in destruction of the less resistant polyhedral cells beneath *ipso facto*. It remains, therefore, for the basal layer to weaken itself out of proportion to the maximum resistance of the cells it has produced. This is the state of affairs in the case of (1) entirely new squamous epithelium, such as we have just discussed, and (2) old squamous epithelium which has undergone rapid and continued activity as the result of

perceive the true delicacy of the epithelial cell reaction. Moreover it is from a study of this type of reaction as a basis that one may come to understand the cellular upheavals associated with the grosser irritants.

Figure 35 shows an example of the reaction to this degree of irritation. Beneath the somewhat thicker epithelial covering, the lymphocytic infiltration is seen to be slightly denser. The metaplastic activity of the basal cells, which are here well seen to be of a definite columnar type, is observed to be slightly greater in connection with the slightly denser zone of infiltration. The distinction is slight, but definite, and undoubtedly proves the delicacy and uniformity of cellular response to irritation.

Under the high power one may once again observe the specific metaplastic function of the basal columnar cells. The process of cell and nuclear division may be seen—an elongated cell containing two nuclei, the upper half of this cell being destined for the passive protective role of the polyhedral type (Fig 36).

With the consideration of this lowest degree of irritation, we complete the study of the effects of irritation generally upon old squamous epithelium. The five main degrees into which irritants have been divided are based, as previously explained, upon the constancy of the associated factors in each, viz (1) the density of the inflammatory infiltration produced by the irritant and (2) the cellular reaction invoked. The histological picture in each case is constant.

#### THE CANCER PHASE—ITS RECOGNITION WITH REGARD TO SQUAMOUS EPITHELIUM, AND THE EFFECT OF AN IRRITANT OF THE THIRD DEGREE OF VIOLENCE UPON NEW SQUAMOUS EPITHELIUM

In the foregoing text I have attempted to stress two points particularly (1) the delicacy and constancy of epithelial cell behavior under varying conditions, and (2) the histological and physiological distinctions between old and new squamous epithelium and columnar epithelium.

To my mind, from the examination of this series, the epithelial response to an obvious

stimulus in all its varying degrees is so constant a thing that one can not for a moment credit the possibility of behavior other than constant under any other circumstances or set of circumstances, on the part of these cells which have been only too ready to disclose their methods of weathering the mildest and severest storms of irritation.

Should it not be very probable then, that the very inception of cancer change in these same cells is the result of a similarly constant phenomenon?

It remains to acquire and study examples of the very earliest evidences of malignancy in the cervix, so early that histologically it has hitherto been impossible to recognize them as such.

The cervix removed for malignancy is of course, useless in this respect, the condition being too advanced histologically, but in a long series of cases such as now under consideration, examples of the beginnings of cancer may be found. Even then, however, slight as may be the evidence, the very definite character of it may be sufficient to mark the mode of its inception. It is not sufficient to say, "This epithelium has gone to the length of cancer change." The phases immediately preceding that change must be recognized—the Cancer Phase. The reason for something distinct from the cell reactions hitherto discussed which are associated with varying stages of cervicitis and ulceration, must be elucidated. We now thoroughly understand the pathology of erosion and ulceration as also the minute reactions of the epithelia involved in these conditions. We have accepted the fact that these states are predisposing factors to cancer growth. All pathological evidence has been overwhelmingly in favor of this being the case. My pathological findings in this series support this fact.

The stepping stone between the benign and malignant must be found—the link between cervicitis (erosion) and cervical cancer.

We have previously discussed the question of the relative age of the cellular elements composing the squamous covering (Part 2, par 1) and have recognized the distinction

the tissues in which it is situated readily enable these inflammatory cells to form actual contact with the new basal layer. This fact can be observed. Localized zones are seen in which the columnar cells of the basal layer are responding nobly to this unforeseen irritation and are reacting in truly typical style. The actual cell and nuclear division can be seen even under the low power. (This fact furnishes yet another proof of the nature and formation of these cells.) The under surface of the epithelium therefore bulges downward in very slight degree here and there. The irritation is obviously of very short standing as yet. The metaplastic activity of the basal cells has only just begun.

In other areas, however, it can be definitely observed that the inflammatory cells have broken through the basal layer and are in actual contact with the most recently produced polyhedral cells. The basal layer has failed at last in its protective function. Its continued and prolonged activity has weakened it out of proportion to the maximum powers of resistance of the cells it has just produced. One can make out the scattered and macerated cells of this layer in the general exudate.

The reaction on the part of the subjacent cells is that for the observation of which we have conducted this search.

In this particular case the reaction is just commencing and has only proceeded to the extent of relatively slight increase in cell formation. It is, however, definite. There is a generalized loss of cell outline due to a general protoplasmic diffusion through the cell walls. There is a generalized lack of cell individuality. Overdistention of existing cells by deeply staining cytoplasm is noted. There is loss of cell shape possibly by bursting. Already irregular shaped and mitotic nuclei can be seen. Large diffuse nuclei shade off into the surrounding cytoplasm.

The whole affected cell mass is blurred and ill defined. There is multiplication by proliferation. The depth of the epithelium is increased. The newly formed polyhedral cells, temporarily possessing in high degree the wherewithal to reproduce their kind, are

proliferating actively under stimulation, and at the expense of their own existence. Each new cell produced in this way and at this speed from a newly born (by metaplasia) cell as a base, must inevitably possess less of the characters vital to functional life than its predecessor. The exact nature of these characters does not concern us in this investigation. Enough has been written upon the subject of cell morphology in cancer to make this clear. My object is concerned solely with the recognition of the onset of this change and I believe that here, in this specimen under examination, one may perceive the earliest evidence of the incidence of cancer in the human subject.

Figure 38 shows a view of the temporary and spasmodic metaplastic activity of parts of the basal layer and also the appearance which I have described as typifying the earliest onset of cancer change. The relatively loose nature of the subepithelial infiltration, corresponding to the third degree, is seen. The atypical nature and shape of both cells and nuclei, together with the protoplasmic diffusion which results in a blurring of the affected cell mass is also observed. There is a slight increase in cell depth of the epithelium caused by the new cell production. With regard to squamous epithelium, this is the moment of change from benign to malignant—the Cancer Phase. In every way, notwithstanding the slight degree of change from the normal here produced, the histological picture conforms in detail to that present in developed cancer.

In the case under observation the subepithelial infiltration, which has brought about the specific changes just discussed, shows areas of increased density in two or three separate and distinct regions. The squamous epithelium in contact with these areas, which correspond to an irritant of the first degree of virulence, is locally destroyed with little or no reactive change, thus agreeing accurately with the behavior of old squamous epithelium in contact with a similar irritant. Figure 39 shows this phenomenon. The complete absence of cell reaction is noticed, the picture being one of rapid destruction. Naturally one expects

irritation, a condition of things observed in connection with ulceration. In this latter case, however, the resultant columnar and polyhedral cells produced are relatively more resistant and stable than those of entirely new epithelium—in so far as they have been produced by a regular, if rapid, metaplastic activity on the part of basically old and original columnar cells, in contradistinction to a new cell production from a basal layer which itself owes its presence to proliferation.

However, there is no doubt that this latter condition does present that proportional diminution in protective strength to the basal layer necessary to the inception of cancer, but, as I have stated, not in so marked a degree as in the former state, and we shall see that it is the new epithelium therefore which provides the most favorable basis for cancer growth.

Figure 37 is derived from a cervix which was removed during the routine operation for prolapse. The cervix was somewhat hypertrophied and exhibited the gross appearances associated with old erosion—a chronic catarrhal exudate, the presence of nabothian follicles, and so on.

Histological examination of this cervix however, discloses a relatively small area of the portio near to the external os, which shows evidence of a recently recovered erosion. The new epithelium is of more or less uniform thickness. The cells composing it stain fairly deeply throughout. Their nuclei are relatively prominent by reason of their size and deep staining property. The contents of these cells possess in the greatest degrees those qualities which are the birthright of the infant cell—that cell which is newly produced by the very specific activity of an older type, produced as the result of metaplasia. The cell contents show plainly the ease with which such a cell could respond to external stimulus by proliferative multiplication in the effort to reproduce its kind, an activity which must inevitably lead to the gradual retrogression of the type.

It is evident that these newly produced cells possess, for a time, an excess of the normal constituents—a protective measure

against absolute extinction at birth—which is quickly absorbed as the cell proceeds to its passive function, receiving its protection thenceforward from more recently produced cells of the same kind, if not from the basal layer itself. It is a fact that the cytoplasm and nucleus diminish in bulk and character (as evinced by the diminution in basic staining property), as the cell is extruded to the surface, that is, as it becomes older, as it recedes farther from the possibility of external stimulation, and as it becomes progressively more and more passive functionally. I cannot say that these cells, at birth, possess for a time by derivation, something of the specific metaplastic function of their forbears, except in so far as their obvious preparation for activity is concerned. The cells produced by them are of the same type though rapidly proceeding to the parasitic or malignant.

In the section under consideration, the cells even of the superficial layers show well marked nuclei. There is no horny layer of flattened, empty cells as yet. The basal layer is well seen and the columnar nature of its cells can be observed. There is a certain rarefaction of the subepithelial tissues, relatively wide spaces intervening between faintly staining muscle elements. There is no evidence in this case of hyaline deposit but this occurs in varying degree in certain other cases. I attach no great importance, however, to this factor as it in no wise affects the point at issue. I consider hyaline deposition as an occasional associated factor in subepithelial rarefaction. Proliferated and distended cervical gland spaces are present in this section and encroach to the edge of the area under examination. The whole is a picture of a recently recovered eroded zone. How recent one can only guess.

Beneath, and in contact with this new epithelium is an acute inflammatory exudate, of marked polymorphonuclear character but in no way differing from exudates of equal density observed heretofore. This exudate corresponds to that which is produced by an irritant of the third degree of virulence. Its density is not great. The cellular exudate is moderately scattered but the rarefaction of

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junction between these cell masses and those produced as the result of the activity of old epithelium is distinct. In reviewing this long series, the various distinctions in cell morphology are evidenced time and again. There is no distinction, however, so definite as that which exists between a collection of infant cells, such as occurs in the production of this phase, and all other types.

Yet another instance, and this somewhat more advanced still, can be observed in Figure 42. Here the new epithelium has produced atypical downgrowths of the type described over a minute area. The subepithelial infiltration in contact, which is responsible, is very typical and the method of production of these downgrowths from the new polyhedral cells corresponds to that already described. Here is a case which exhibits an area, totally included within the field of the low power of the microscope which is passing through the interstage between the benign and malignant. The same may be said of the case from which Figure 41 is taken. In the case from which Figure 40 is taken a greater length of epithelium is involved but this is because the process of healing has of necessity involved a larger area.

The production of the cancer phase with regard to squamous epithelium, therefore, results from the effects of an irritant corresponding to the third degree of virulence, acting in contact with the under surface of relatively new epithelium. It is, of course, impossible to say for what length of time this action must be maintained in order to produce this result. By comparison, it appears to me to be quickly produced. The important point is that the infiltration is not in sufficient concentration to destroy utterly. Only the attenuated basal layer is destroyed. Moreover, the attack is delivered from below. There is every facility for the production of a subepithelial inflammatory reaction by direct spread throughout the rarefied supporting tissues, but whether or not this is the case I am not prepared to say. Possibly the irritant is conveyed by the blood stream in this instance. However, it is necessary for a distinct recurrence of the irritation to occur

in a subepithelial situation and during the time of instability of the epithelium. Undoubtedly the cancer phase reactions described are progressive from this point. There is no doubt that these reactions must increase rapidly with each new cell produced. Moreover, as the mass of infant cells becomes larger and consequently more parasitic in type, the infiltration in contact will increase in density both by reason of the presence of an increasing "foreign" element, and of the fact of increasing tissue activity and also on account of the increasing ease of secondary involvement by septic organisms as the result of progressive surface softening in the affected area. We, therefore, see in cases of developed cancer an associated inflammatory reaction which approximates more nearly to the first degree of virulence, but we must remember that this was not the one concerned in the initial production.

Figure 43 shows one of the earliest evidences of developed squamous cancer that I have in my series. The whole affected zone can be included in the low power field. I consider, however, that the cell morphology is typical. The area involved corresponds to that of an erstwhile healed erosion. Proliferated cervical gland spaces can be seen beneath this minute cancer. The general softening, which affects the surface, can be observed and the localized dense inflammatory infiltration which surrounds the involved epithelium is undoubtedly partly derived from bacterial infection through the surface. The junction with the more normal epithelium is abrupt because of the difference in density of the adjacent tissues causing separation on cutting. Yet the distinction between the cell reaction here and that seen and described in the preceding cases is barely discernible. The transition takes place insensibly and is now complete. Figure 44 shows the high power view at the junction of the normal epithelium.

I feel that the link between the benign and malignant is bridged by the full consideration of the cases concerned in Figures 37 to 43. There is no doubt in my mind as to the mode of transition and I trust that this has now been made clear.



this to be the case, the new squamous epithelium being less resistant in all respects than the old. It is, however, all important to observe, in the one case, the two cell reactions toward two degrees of irritation, and to compare these with those occurring in the case of old epithelium. The effect of the irritant of the first degree must necessarily be the same in each case, but that of the third degree depends upon the type of squamous epithelium involved, the cancer phase being the outcome of the effect of an irritant of the third degree upon what we now recognize to be new epithelium.

Figure 40 shows a somewhat farther advanced stage of this phase. In this specimen one may recognize the junction between the old squamous covering and the newer epithelium which has recovered an old eroded zone. The widespread subepithelial rarefaction which is present in conjunction with the line of new epithelium, which proceeds down to the region of the cervical glands, is typical. The type of new epithelium is also typical, the general thickness being in this case uniform, except where now obliterated or stimulated, and the cells composing it more nearly approximating to one another as regards age than those of old epithelium. Here in this specimen, however, there has obviously occurred a recurrence of epithelial irritation which is affecting this newly healed area, and this is evidenced by the presence of an acute subepithelial inflammatory exudate in contact. This exudate varies in density in parts of the affected area. Where it approximates to an irritant of the first degree, the epithelium in contact is destroyed wholesale without reaction. This is the case over a relatively large area in this specimen. When the density of the infiltration corresponds to an irritant of the third degree, the typical epithelial reaction is produced. In this case one may observe the contact made between the exudate cells and the polyhedral cells of the epithelium. It is possible to see small groups of faintly staining basal columnar cells scattered by desquamation but still in the region of their normal position. They are no longer functioning. Masses of irregularly shaped cells are locally produced by prolifera-

tion from the activity of polyhedral cells. The most recently produced are often grossly enlarged and engorged by their cytoplasm. Their nucleus is large and diffuse. There is no longer any base line to the squamous epithelium. Irregular perforations of it have taken place and irregular cell masses composed of infant cells, many indistinguishable from the malignant, are beginning to penetrate into the rarefied tissues beneath. In other parts the basal cells are seen to be still functioning but it is obvious that the rate of activity is great. The type of polyhedral cell produced is not normal. It is too large, too distended, too deeply staining. Its nucleus is too diffuse. In some cases nuclear division can be seen. The cell produced is too primitive. However, where metaplastic activity has for a time prevailed, epithelial downgrowths of varying degree are formed. They are nevertheless quite distinct from those brought about by the activity of old epithelium.

It is but a trivial step from the phase which we have just observed to that of developed cancer. Differences hardly perceptible would lead to a definite assertion as to the presence of cancer. There is no doubt that the rate of cell activity in the phase just observed is even increasing. Each new cell produced is more active from a proliferative point of view than its predecessor. Soon the picture will be dominated by typical cancerous activity. This crucial phase will be obliterated. The vast majority of specimens examined are typical and hence useless from our point of view. The onset of developed cancer is associated with an increase in the density of the inflammatory reaction in contact. This is only to be expected since a relatively large area is involved by the presence of foreign cells. Also the secondary infection by pathogenic organisms is immediate once access is obtained and this is simple in surface cancers.

Figure 41 shows another instance of this vital phase. Here a subepithelial inflammatory exudate approximating in density to the third degree has destroyed the basal layer and by affecting the polyhedral cells directly, has produced atypical downgrowths consisting of typical primitive cells. The dis-

cells, morphologically similar to those produced by the columnar cells of the squamous basal layer. Prolonged stimulation of these cells, therefore, results in the production from them of a different type of cell, a process of delayed metaplasia analogous to but much less easily provoked than that seen in connection with the basal squamous layer. In other cases they may react by sudden and irregular gland multiplication, a process which proceeds directly to the malignant. Both these reactions, where truly original gland elements are concerned, are extremely rare. With regard to the former reaction, there is always some associated gland proliferation, which occurs in the presence of irritation, *ipso facto*, so that one may practically assert that direct cell change does not occur from original gland epithelium.

Indeed, it is only in the relatively rare cases of localized acute intracervical irritation, which occurs in the absence of surface erosion, that the original gland epithelium is affected in this way. In the vast majority of cases surface irritation involving the squamous epithelium is present, and in these the deeply placed gland elements show no cell reaction. It is left, therefore, to the newer gland elements, those resulting from direct proliferation in cases of surface irritation, to exhibit that type of change which proceeds inevitably to the malignant.

Figure 45 gives a good instance of the tremendous resistance of this type of epithelium. Here recently produced glandular elements are surrounded by an inflammatory infiltration of great density—equal to the first degree of irritative virulence. Little or no reaction results, however, in the cells themselves. The inflammatory exudate does not penetrate the basement membrane—which I consider to be extremely resistant—and the glandular epithelial cells are, therefore, out of actual contact with this exudate. I believe that this fact plays the same important part in the production of individual cell stimulation with resultant change that has been seen in the case of squamous epithelium. Figure 45 merely emphasizes a point that we have observed in many previous instances during our routine study of this series.

Occasionally localized cell downgrowths of minor degree are seen to originate from isolated areas of the surface epithelium of the canal. For the most part these are due to the stimulation of isolated prolongations of the squamous epithelium. Small strips of this epithelium occasionally encroach beyond the normal squamous columnar junction and remain as minute surface patches on the surface of the canal. I have not attached any special importance to these areas and have always found the epithelium concerned in them to react identically with adjacent and more normally situated epithelium of the same kind. In this connection I do not necessarily agree with Moench and other authors as to the excessively sensitive nature of squamous epithelium in this region. Although its presence has been frequently demonstrated in my cases, there has never been any definite evidence of untoward activity associated with it. Neither, indeed, would I expect such to be the case, in view of the normal morphology of its constituent cellular elements.

The new glandular elements, rapidly produced by proliferation, however, cannot possibly possess the resistance of their parent cells. It is in connection with these that we see the eventual degeneration of the glandular epithelium by enforced individual cell multiplication. There is no doubt that the high columnar cells which line the new gland spaces in the region of the surface erosion though morphologically similar, are much less adult than those from which they have originated. If proliferative activity has been rapid, there must be many of these cells which possess little or no further activity in this respect. The normal reaction to irritation is exhausted, just as it eventually is in the case of the basal layer cells of squamous epithelium. Further stimulation results in the direct production from these cells of polyhedral type cells, as the result of a metaplastic activity analogous to that possessed by basal columnar cells. Whereas, however, in the case of basal columnar cells this process can proceed at length by virtue of the specific function of these cells, in the case of these attenuated columnar gland cells this reaction marks their ultimate

I have previously explained that the activity of the basal layer in true ulceration may be such as to weaken locally and temporarily its component cells out of proportion to the maximum power of resistance of the polyhedral cells which it has produced, but that this is not nearly so probable as in the case of entirely new epithelium which owes its existence to recent manufacture by basal cells themselves produced by great proliferation.

Moreover, in the case of true ulceration there is not that transient phase of quiet which allows of the devitalizing specific metaplastic activity of the basal layer. The cellular downgrowths occasioned by active ulceration are controlled for the most part as already explained, and if as rarely is the case, but as Figures 25 and 26 show, there occurs a temporary increase in the virulence of the irritant in contact with these downgrowths, the new polyhedral cells are destroyed without reaction along with the cells of the basal layer. The irritant in contact is too strong to destroy the basal cells and stimulate the polyhedral cell without destruction. For this reason the true ulcer is much less liable to malignancy than the proliferative erosion. As I have said previously, cell destruction is a safeguard against malignancy.

In this respect, therefore, it would be necessary for the adjacent epithelium of a long standing ulcer, one which has passed the active stage, to be re-stimulated by an irritant corresponding to the third degree of virulence, and thus to be done in connection with prolonged downgrowths which have taxed the proliferative and metaplastic powers of the basal cells to the full, and before recuperation on their part has been effected. It would then be possible, but not as probable as in the case of new epithelium, that the basal layer cells in the region of the apices of the downgrowths, that is, the most recently produced, might be locally destroyed, thus allowing direct contact between the irritant and the subjacent polyhedral cells. It is a clinical fact that the development of cancer in connection with ulcers takes place in the long standing chronic type, such as we have

observed in this series, and not in the truly active ulcer.

#### THE CANCER PHASE—ITS RECOGNITION WITH REGARD TO COLUMNAR EPITHELIUM AND THE EFFECT OF AN IRRITANT OF THE FIRST DEGREE OF VIRULENCE UPON NEW COLUMNAR EPITHELIUM

In the chapter dealing with the relative age and function of columnar and squamous cells, I have indicated the extreme distinction which exists in the matter of resistance to irritative stimulus between these two types. The columnar epithelium of the cervical glands is extraordinarily resistant to maceration. This fact has been shown in dealing with the proliferative activity of these cells in response to stimulation by an irritant which is sufficient to destroy with ease, and without reaction the squamous epithelium. The columnar cells of the basal layer of the squamous epithelium, we have seen to possess a degree of resistance relative to their specific function, but in so far as they are a smaller type and functionally much more active, their resistance cannot be nearly so great as that possessed by the large, relatively empty and thick-walled cells the function of which is largely of a secreting nature, and not in any way connected with new cell production.

I regard these columnar cells, which line the normal non-proliferated glands of the cervical canal, as practically immune from malignant change. Cell change in them occurs only as a response to the most prolonged and virulent form of irritation. Their normal reaction, as we have seen, is by direct proliferation and new gland formation. The cells lining the old gland spaces for the most part remain unchanged.

Even gland proliferation, of definite degree, is not provoked by irritants of less than the first degree of virulence. We have seen elsewhere instances of the resisting power of these older gland spaces to irritants of the lesser degrees. When, however, the irritant in contact is prolonged in action and of extreme virulence certainly of the first degree columnar cells very occasionally show a direct reaction by the local production within the gland space of typical large polyhedral

cell production and malignant degeneration. The gland space here shown is similarly surrounded by an inflammatory exudate of the first degree, much of which has penetrated into the lumen. Direct contact is made, both from without and within, with the gland cells. These are now seen to be transformed over the greater part of the circumference of the space, into a mass of ill defined but typical cells of the malignant type. The process here has only as yet just begun. The rapidly multiplying polyhedral cells are seen to conform still to the original outline of the epithelium from which they have sprung. The basement membrane has disappeared. New cells have encroached beyond the normal boundaries. A typical mass of blurred and deeply staining cells in intimate contact with a dense infiltration results. Part of this single gland space is as yet unaffected. The inflammatory infiltration in contact with this part is locally very slight. The columnar cells here have not been stimulated, hence they still remain normal. Here is yet another proof of the necessity of direct contact between exudate and cell to produce cell reaction.

In Figure 47 we see the earliest evidence of definite cancer in glandular epithelium. The two gland spaces shown in Figure 46 and Figure 47 are the only ones in the whole specimen which are affected in this way. Here again one sees the necessity for absolute contact between the inflammatory exudate cells and the epithelial elements before cell reaction takes place. Figure 47 demonstrates this fact well. Without contact there is no reaction.

Figure 48 demonstrates the relatively rare reaction of direct malignant gland proliferation, resulting in the production of a true adenocarcinoma. This reaction invariably takes place in association with the deeply placed and original gland elements and is provoked by their direct contact with a dense inflammatory exudate corresponding to an irritant of the first degree. My cases show that it is rare to find these old glands involved by direct contact with an irritant in the absence of a surface erosion. Even in the presence of this latter condition, the vast

majority of cases show a relatively slight degree of direct involvement of the glands situated high in the cervical canal. The inflammatory exudate, in practically all the cases, is, for the most part, in association with the newly proliferated elements. An active irritant of the greatest virulence, involving the glands of the cervical canal locally, there being no spread to the portio or to the uterine cavity, is a very rare condition. A scrutiny of the cases of this series bears this out. I have said elsewhere that I believe these old glandular elements to be practically immune to cancer change. Their natural reaction to irritation is by direct proliferation. Very rarely is any other reaction required. Direct contact irritants are nearly always of a minor degree. The only irritant capable of calling forth an alternative reaction is one of the greatest virulence prolonged in its attack, that is, one acting directly upon these gland elements and analogous, either by reason of its own inherent virulence or by reason of the state of the patient's resistance, to that observed in the production of true surface ulceration. Under these conditions it is readily understandable that the natural and initial reaction of these gland elements to irritation will be provoked suddenly and continuously and out of proportion to their productive power, with the result that true glandular malignancy will be produced. I therefore regard these old gland elements as indestructible by pathological irritants.

The condition of solid alveolar carcinoma, resulting from the malignant production of polyhedral type cells from new columnar epithelium, as already described, is, however, the condition of importance, in so far as its occurrence is greatly in excess of true adenocarcinoma. We have completed our study of the incidence of the cancer phase in this respect. From this point it is but an insignificant step to that of developed cancer. My object in this instance therefore ends with the observation of this all important phase.

*Developed cancer.* I have only one thing to say with regard to developed cancer. It is necessary for me to emphasize my firm belief in the origin of carcinoma from pre-existing

response to the contact irritant and results in the inevitable and rapid extinction of these cells, which at last have been forced to the production of a type lower in the scale than themselves. This process, therefore, soon negatives the remaining resisting power of the young columnar cell which is soon destroyed and thenceforward, direct cell multiplication by proliferation with consequent inevitable degeneration in type, proceeds from the newly produced polyhedral cells. The hitherto well marked basement membrane, upon which the columnar gland cells rest, is broken, and encroachment by the now potentially malignant cells proceeds beyond the normal confines. Moreover, the inflammatory exudate, hitherto mainly located outside the gland space, penetrates within the lumen and establishes direct contact with these cells, thereby increasing the rate of production and ensuring the onset of malignant change. The type of polyhedral cell produced from the columnar gland cell is seen to approximate rapidly to that produced by direct proliferation of squamous polyhedral cells. It is infantile in type and distended by deeply staining protoplasm. It possesses an ill defined and large nucleus and ill defined and large cell walls. A collection of these cells present the typical blurred appearance noted in connection with the cancer phase in squamous epithelium.

Whereas, however, the cancer phase is produced in squamous epithelium by the action of an irritant of the third degree of virulence in direct contact with otherwise normal if young polyhedral cells, it is necessary for an irritant of the first degree to penetrate the basement membrane of attenuated gland epithelium or, even if in direct contact with the cells from within the lumen, to stimulate this type of cell to its last response.

We have seen in the case of squamous epithelium that an irritant of the third degree stimulates without destroying—a necessity in the production of malignant change. An irritant of the first degree destroys the young polyhedral cells of the squamous layer. These are, however, very different in type from those produced by the young gland cell. They are normal cells in themselves, produced

by the normal specific function of the basal layer, and for the purpose of a normal function when necessary (protective). On the onset of the cancer phase, we have seen that the density of the associated inflammatory exudate increases to that corresponding to the first degree, but cells potentially malignant or developed in malignancy are not now affected by this contact.

The cancer phase with regard to squamous epithelium, therefore, is developed from these young polyhedral cells, after destruction of the extremely attenuated basal layer. The cancer phase with regard to columnar gland epithelium is developed directly from the youngest proliferated cells—of similar morphology and function to that possessed by the highly resistant parent cells. The strongest irritant is, therefore, still necessary in its production. Cells, potentially malignant, are almost immediately produced there being no true metaplastic function possessed by these gland cells, and the rapid and progressive degeneration in type proceeds in the presence of this irritant, which, in this case, is similarly inadequate to destroy cells that have definitely embarked upon the malignant course.

Figure 46 demonstrates the cell reactions which immediately precede the onset of malignant change in young columnar gland epithelium.

Here, one may observe a newly produced gland space, situated deeply. It owes its presence to proliferation from older gland elements in response to the presence of a surface ulcer. This gland space is surrounded by, and is in intimate contact with an inflammatory exudate of a density equal to an irritant of the first degree of virulence. The basement membrane is seen to be perforated from without and a quantity of inflammatory cells are observed to have penetrated, via this perforation, into the gland lumen. In another area the commencement of direct cell stimulation by polyhedral cell formation can be seen. This gland space is about to exert its final cell response prior to the inevitable onset of malignancy.

Figure 47 shows an adjacent gland space in the same section. Here the process has advanced to the definite degree of irregular

cell production and malignant degeneration. The gland space here shown is similarly surrounded by an inflammatory exudate of the first degree, much of which has penetrated into the lumen. Direct contact is made, both from without and within, with the gland cells. These are now seen to be transformed over the greater part of the circumference of the space, into a mass of ill defined but typical cells of the malignant type. The process here has only as yet just begun. The rapidly multiplying polyhedral cells are seen to conform still to the original outline of the epithelium from which they have sprung. The basement membrane has disappeared. New cells have encroached beyond the normal boundaries. A typical mass of blurred and deeply staining cells in intimate contact with a dense infiltration results. Part of this single gland space is as yet unaffected. The inflammatory infiltration in contact with this part is locally very slight. The columnar cells here have not been stimulated, hence they still remain normal. Here is yet another proof of the necessity of direct contact between exudate and cell to produce cell reaction.

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*Developed cancer.* I have only one thing to say with regard to developed cancer. It is necessary for me to emphasize my firm belief in the origin of carcinoma from pre-existing

epithelium. Wilson has pointed out the frequent histological demarcation which exists between the carcinomatous cells and those of the adjacent epithelium, and has suggested that the direct origin of the one from the other is not yet proved. More recently Schiller has noted this appearance and speaks of an "oblique groove" which runs between the benign and malignant tissues.

The cases of developed cancer in this series have also shown a distinct demarcation line in practically every case. I regard this, however, as an artefact, and produced in cutting the sections. The density of the normal epithelium and its subjacent tissues is much greater than the loose, semi-liquefied and almost entirely cellular malignant tissue which itself extends to a relatively great depth. There is a great difference in consistency between these two adjacent tissues. On cutting thin sections therefore it is almost impossible to prevent separation at their junction—especially at the surface.

Figure 49, however, shows a developed cancer and demonstrates the contact between the benign and malignant cells.

#### THE BASIC CAUSE OF CERVICAL CANCER

From the foregoing it will be seen that my endeavor, in attempting to elucidate the problem of the relationship between cervicitis (erosion of the cervix) and cervical cancer, and incidentally to acquire a knowledge of the nature of cancer inception, has been to place these conditions as a whole upon a common basis. A study of my cases has shown that the one phenomenon common to all is the associated presence of an inflammatory exudate. Also that epithelial reaction, no matter by what type of epithelium, depends entirely upon intimate contact between the cells of the exudate and the epithelium concerned. One has also learned that the type of epithelial reaction produced depends directly upon the nature and function of the epithelium, and also upon the density and accessibility of the inflammatory exudate in contact with it.

There has been no exception to these rules throughout this long series of cases. Epithelial activity has never occurred in the

absence of a contact exudate. The type of reaction, under the various conditions, has been so constant as to impress me, beyond any doubt whatever, with the fact of the constancy of cell behavior. Once the relative values, in terms of age, function, and type, of these cells are understood, and the associated external factors taken into true account one might almost evolve the histological picture which would result from any given combination. There is nothing atypical in cell behavior in response to irritation until malignancy is reached. Even then, the "anaplastic atypia" is merely a matter of the phenomenon of malignancy itself, and is in no wise concerned with the factors which produced it. Once the border line is crossed the causal agent plays no further part. The stimulus has been given. What proceeds thereafter does so, in spite even of many additional external factors which thenceforward are present, and is, in itself, progressive and inevitable. That, however is not part of our concern. Our inquiry ends at the inception of this phase, which is brought about as the result of direct contact between inflammatory exudate cells and certain types of epithelial cells.

The inflammatory exudates observed throughout the whole of this series, and including those concerned in the production of the cell changes referred to, are typical and identical. There is no variation in type as far as the component cells are concerned. The relative numbers alone vary according to the degree of acuteness of the inflammation produced.

As previously explained I have preferred to use the word "irritation" in preference to 'infection' in dealing with these exudates, in so far as it is presumably possible for them to be produced by the action of purely chemical irritants as well as by bacterial organisms. The concentration of either of these agents, however, is in the immediate vicinity of the exudate produced and there is no histological distinction in type resulting from their action, except, as I have said in the matter of degree. These exudates therefore may result from the action of either of these agents. In the case of the cervix uteri, however, there

is no doubt that septic organisms (including the gonococcus) are very frequently concerned, and, in my opinion, it is impossible to ignore the fact that organisms of this kind are directly responsible in the production of most, if not all, of these exudates. The discovery of the exact organism or chemical does not concern us. There is no reason to disagree with Gye's theory of a filtrable virus in this respect. He has concentrated upon the recognition of the initial causal factor in the production of cancer.

The nature of cancer, when produced, also forms no part of this work. Blair Bell and others have probed deeply into that aspect. Blair Bell regards the initial causal factor as unimportant in comparison with the nature of cancer itself, from the point of view of treatment. It is toward the recognition of an *intermediate causal factor* that this work has been directed. Whatever the initial cause be it is its direct expression which acts upon epithelial cells eventually to produce cancer change, and this—a typical inflammatory exudate—is a constant factor toward this phenomenon.

I have divided the exudates concerned into 5 types according to relative concentration (Part 2, par 1), thus representing irritants of five degrees of virulence. I have avoided a definite cell count in connection with this division on account of its arbitrary nature, as explained. Nevertheless I believe that in each individual case the actual cell concentration of this exudate marks the degree of irritation exerted by it upon epithelium in contact. The fact that exudates of equal density may be produced in different cases by organisms or chemical irritants of varying virulence according to the resistance of the patient concerned is of importance, in so far as it increases the value—as the causal agent—of this intermediate factor, which alone acts constantly. The same initial factor acting in a number of cases, might result in the production of exudates of varying density in each. The cell reactions would therefore also vary. Cancer may be produced in one and not in another.

The densities of the two chief exudates, those corresponding to irritants of the first

and third degrees, are distinct. It has been seen that the action of an exudate corresponding to an irritant of the first degree of virulence is necessary to the production of cancer from columnar epithelium, and that one equal to an irritant of the third degree is sufficient in the case of squamous epithelium. In the latter case direct contact is assisted by subepithelial rarefaction. The exudate is in contact from below, but there has always been evidence of a surface gap from which direct subepithelial spread has undoubtedly been effected. I do not therefore consider this phase to be due to a secondary subepithelial irritation, emanating possibly from the blood stream.

I would, therefore, assert that the basic cause of cervical cancer is the effect of an inflammatory exudate (being the visible sign of an irritant of bacterial or chemical nature), acting directly upon epithelial cells, and of a density varying in accordance with the type of epithelium involved.

The nature of cancer inception is that of a pure cell reaction on the part of pre-existing but newly produced epithelial cells.

I do not believe that a single initial cause can produce this effect, constantly and in all cases, in connection with epithelium of one type alone, much less in connection with epithelia of different types. I do not therefore believe that there is one great initial cause concerned in cancer production, but that a variety of initial causes actually conduce to this end—through the agency of this single intermediate cause which alone is constant.

Cancer change in squamous epithelium is provoked by a re-irritation of new epithelium, in columnar epithelium, by a prolonged and constant irritation of great intensity, which is probably repeated many times.

As we have seen, the distinction between "new" and "old" squamous epithelium is arbitrary and not absolute. Epithelium of this type may be said to be "new" so long as the resistance of the columnar cells of the basal layer is less than the maximum resistance of the subjacent polyhedral cells. At the moment that the resistance of the basal layer becomes greater than that of the subjacent cells, in consequence of freedom from irritation or metaplastic activity over a period of



time, the epithelium concerned may be said to be "old."

In this respect, therefore, the phenomenon of cancer inception is a cell reaction which depends as much upon the time of its onset, within arbitrary time limits, as it does upon the factors which conduce to it.

#### CONCLUSION

Without further repetition, I have little to say in conclusion except that

1 Cervicitis, erosion of the cervix, is definitely related to cancer of the cervix.

2 This relationship is effected through the agency of a factor common to both—an associated inflammatory exudate in contact with epithelium. This is the intermediate causal factor and is constant.

3 The basic cause of cervical cancer is to be found in this constant factor which is associated with all cell reaction, including that of cancer inception.

4 The phenomenon of the action of contact inflammatory exudates of varying degree upon epithelia varying in type, forms this intermediate causal factor, or basic cause, in the production of cancer.

5 There is no one great initial cause of cervical cancer.

6 In the case of squamous epithelium the change is produced as the result of a re-irritation of minor intensity affecting newly produced cells. In the case of columnar epithelium it is produced by a prolonged and intense irritation affecting new epithelium—probably recurrent.

7 As far as the cervix uteri is concerned, I am inclined to the belief that the initial causal factor concerned in the production of the intermediate causal factor is bacterial, and is moreover concerned to a large degree with the well known septic organisms. Recurrent attacks of specific intensity, from the epithelial standpoint, involving epithelium during the danger period, result in the production of cancer. The question of the time

at which this attack is made, therefore, plays its part, and this fact is undoubtedly instrumental in minimizing this catastrophe.

Whatever initial causes there are in the production of cancer growths, whether bacterial or chemical, the effect is produced through the agency of this constant intermediate factor. The result is the production of the cancer process, which again may be variable in its intrinsic nature, although in relation to the epithelia of the cervix uteri this phenomenon shows a rare degree of consistency.

I wish to emphasize, therefore, that whereas there may be, and in my opinion undoubtedly are, many initial causes in the production of cancer, and the nature of the growth itself may even be atypical, nevertheless there is always one factor concerned in this process which remains constant in type for all epithelia, and, moreover, constant in degree according to the nature of the epithelium concerned. It is this, therefore, the intermediate causal factor which I have described, which in my opinion is of such great importance in association with the phenomenon of cancer inception.

As I have said elsewhere, the nature of cancer inception is that of a pure cell reaction, dependent alike upon the type of epithelium involved, the span of time during which the young cells are affected and the degree of intermediate causal association with them at that time.

5 Alterations in the densities of contact inflammatory exudates results in alterations in the cell reactions produced, *ipso facto*. An alteration in the density of the exudate concerned during the epithelial danger period, whether pathological or therapeutic, would result in an altered cell reaction. Involved epithelium at this stage must frequently just escape cancer change through pathological means, resulting from coincident changes in inherent resistance. Is it possible to effect the same result by therapeutic means?

## SPASTIC ILEUS

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IN the final decade of the last century the idea became current that spasmodic contraction of the intestinal musculature might obliterate the lumen of the bowel for a varying period of time and lead to the picture of intestinal obstruction. Israel speculated on the phenomenon of obturating gall stones which became fixed after having traversed a portion of the intestinal tract without difficulty, and he attributed part of the occlusion to contraction of the bowel wall about the concretion. Koerte, too, was impressed by the fact that small stones not infrequently gave rise to intestinal obstruction. He hypothesized that the stone delayed the passage of intestinal contents without actually obstructing them. Fermentation then occurring in the stagnant contents released irritating substances which provoked exaggerated peristalsis and spastic contraction of the bowel about the stone. It remained for John B. Murphy, however, to demonstrate a spastic occlusion of the intestine at laparotomy in a patient suffering from lead poisoning. In 1897, the year following, Haidenham, in a paper read before the German Surgical Society, presented spastic ileus as a clinical entity and reported 3 cases in which the enterospasm was demonstrated at operation. There was considerable opposition to the statements of Haidenham at that time but, in the 30 years that have followed, the existence of a spastic or dynamic form of ileus has become established beyond reasonable doubt. The total number of reported cases, however, is not large. Fromme, in 1914, collected 20 cases in which the diagnosis was confirmed at operation. In 1920 the number according to Sohn had reached only 30. The following year Nagel gathered from the literature 51 cases which had been proved at operation or autopsy. I have collected 157 cases from the literature, in which the condition has been adequately demonstrated on either the operating or postmortem table or both, and to this number have added two

observations of my own. The reported cases probably constitute only a small percentage of the total number occurring, as is evidenced by the fact that Koerte was able to report 28 of his own cases, all of which were confirmed at operation or autopsy. It is highly probable that many of the cases of intestinal obstruction which have responded to treatment with antispasmodics, heat, or other non operative measures were really spastic in origin.

Spastic ileus has been defined as an intestinal obstruction the origin of which depends solely on a persisting contraction of the intestinal musculature. According to an excellent description by Freeman, "Spastic ileus is due to a spasmodic muscular contraction of a portion of the intestinal tract. It may affect either the small or the large bowel or both, in one place usually, or possibly in many places. It generally includes a few inches of the gut only, although at times a considerable length is compromised. A common location is the lower portion of the ileum. The typical appearance is striking and unmistakable. A section of gut a few inches in length is contracted to the limit, rendering it white, bloodless, and so firm that it often may be picked up by one end and held horizontally without bending. The contracted part does not merge gradually into the adjacent bowel, but stops abruptly at either end, the rest of the intestine remaining normal, but if the trouble lasts long enough the proximal bowel dilates as in any other form of obstruction. The spasm frequently persists after the abdomen is opened, although it may disappear, and it is sometimes found even at autopsy." It might be added that often the manipulation incident to laparotomy and exploration is sufficient to cause the spastic portion of bowel to relax, and the collapsed segment has frequently been observed to fill out under the hand of the surgeon.

Because its clinical picture lacks exact definition spastic ileus does not lend itself well to statistical study. It is difficult to establish

a positive pre-operative diagnosis and often impossible to rule out mechanical factors. It has, therefore, been correctly stipulated that only those cases in which the diagnosis has been verified at operation or autopsy should be tabulated. Many cases which occur and subside spontaneously or with conservative treatment would be omitted in such a study. Nor will the operative or postmortem findings include all cases. Although the spasm often persists in spite of general anesthesia, it is probable that it sometimes yields in narcosis, and though spastically contracted bowel has been found at necropsy, it is to be assumed that in some instances the contractions will have relaxed in death. On the other hand, it is possible that spasms found at autopsy may have been agonal rather than factors in the cause of death. Furthermore, there is no sharp limitation as to what shall be included under the term *spastic ileus*. The clinical picture of enterospasm varies from the acute, severe cases, which simulate acute mechanical obstructions, through the subacute and chronic forms, to the mild spasms which cause simple constipation or slight discomfort suggestive of gall bladder or appendiceal disease. Again, if spasm plays a part in obturating obstructions, as Israel and Koerte have suggested, which cases shall be ascribed to the foreign body and which to the spasm? Finally, it has been claimed that intussusception often begins as a spasm, and localized spastic contractions have been seen accompanying or following the reduction of invaginations. A sharp differentiation between these two conditions is, therefore, often very difficult.

Spastic ileus, like other functional disorders, may result from a wide variety of different conditions, and considerable discussion has arisen as to the mechanism of the contraction. Frequently, several factors seem to be present, and various writers differ as to the relative importance of the individual components. There are those who see local irritation of the bowel or of its adjacent structures as the dominant cause. Some ascribe the greatest importance to changes in the vagus nerve or the retroperitoneal plexus, and others lay the condition essentially to psychic disturbances. Pototschnig assumes the presence of

a "tendency to spasm" of the autonomic system as a necessary prerequisite of spastic ileus. Steindl has found organic changes in the medulla of patients dying of spastic obstructions and believes that such occurrences are due primarily to a pathological condition of the central nervous system. Payr, on the other hand, has succeeded in demonstrating spasm of the intestinal musculature from experimental occlusion of the mesenteric vessels and would explain the phenomenon on a circulatory rather than on a nervous basis at least in the traumatic forms. Obviously, no one explanation is adequate to account for all of the observed cases.

The innervation of the bowel is very complicated and not entirely understood. According to Mueller, it seems that most of the motility is controlled by the intrinsic nervous plexus—the plexus of Auerbach and Meissner. In addition the function of the bowel is under control of the vagus and sympathetic systems by way of the coeliac and inferior mesenteric plexus. And over all, exerting some measure of control, is the central nervous system. From the great diversity of causes of spastic ileus described, it would seem that stimuli arising in any portion of this nervous apparatus may produce the spasm that interferes with the passage of intestinal contents. The causes of spastic ileus, therefore, fall into three groups, corresponding to the three major divisions of the nerve supply to the bowel.

#### SPASTIC ILEUS FROM STIMULI ACTING ON THE BOWEL AT THE SITE OF SPASM

Every surgeon has seen transient spasms of the intestine from pinching or squeezing during the course of abdominal operations, and contractions of longer duration have been produced experimentally by the use of stronger stimuli. Thus mechanical thermal or electrical irritation, the injection of physostigmin into the lumen, or the painting of adrenalin or barium chloride solution on the serosa have all been found to give rise to such spasms. Moreover excised portions of bowel (Magnus) will respond in the same way to these stimuli, indicating that the reflex is an intrinsic one, by way of the Auerbach and Meissner plexus. Clinically, cases of spastic ileus have fre-

quently been reported due to local irritants analogous to the experimental ones mentioned

*Foreign bodies* Israel and Koerte, as stated before, both described intestinal obstruction from small gall stones which had traversed part of the intestinal tract without difficulty, and they ascribed the occlusion to spastic contraction of the bowel about a stone. Similar spastic segments, due to scybala, have been seen by Schloffer and Sohn, Vogel has reported a case of spastic ileus due to fruit seeds which produced a picture as threatening as one of mechanical obstruction. The foreign body was pushed into the cæcum at laparotomy, and the patient recovered. There is probably an element of spasm in most cases of obturating obstruction. It is difficult to explain why such objects as calculi, gall stones, or fruit seeds, which so frequently form part of the intestinal content with no untoward effect, should, in the exceptional case, lead to severe enough irritation to cause spastic occlusion of the bowel. Perhaps the assumption of Koerte that irritating substances develop in the stagnating contents behind the obturating body will account for it, or it may be, as Florack suggests, that decubitus ulceration from the pressure of the foreign body gives rise to the spastic reflex.

*Intestinal worms* An interesting group of cases due to the presence of foreign bodies is the one caused by intestinal parasites. Two types of intestinal obstruction due to worms have been described: an obturating ileus from massed clumps of parasites and a spastic ileus about one or several worms. Even in the former group, an element of spasm may play a part in the final obstruction. Cases of the second type have been reported by Haidenhain, Hagedorn, Kiesselbach, Kuester, Rost, and Schulhof, in which the spasm was due to ascaria, Barth's case was due to tapeworm, and Dmitrieff's case resulted from oxyuria. Rost observed in 1 year 4 cases in which operation was performed, and he attempted to determine experimentally the cause of the spasm. In testing the effects of extracts of various portions of round worms on the musculature of excised intestine of the cat he found that extracts of the digestive and gen-

ital organs increased the tonus while that of the skin depressed it. He, therefore, concluded that living worms could produce intestinal obstruction by forming large obturating masses, and that spasm was due to death and disintegration of the parasite. Sobn, however, maintains that the irritation is a mechanical one, and his view is supported by the instructive observation of Kuester, who found enterospasm due to a worm at laparotomy and could make the spasm travel up and down as the parasite was pushed to and fro in the intestine. In the case due to oxyuria (Dmitrieff), an ulcer had been produced by the worm, which had perforated to the serosa. It is possible that some of the cases in which no cause for the spasm could be found at operation may have been due to intestinal parasites. Nordmann operated upon a child 2 years old under the diagnosis of strangulation ileus and found spasm. No cause was discovered, and only after the child passed a clump of worms a year or so later was the etiology of the attack explained. Barth's patient developed spastic ileus following colporrhaphy. At laparotomy enterospasm was found without attributable cause, and only autopsy revealed the tapeworm in the contracted portion of the bowel.

*Undigested food* Several cases are on record in which no other cause for the enterospasm could be found than indigestible foodstuffs. Engstad recently reported one in which the patient gave a history of having eaten at least twelve ears of sweet corn on the preceding day, and another in which excessive intake of ice water on a very hot day seemed to be the sole cause of the attack. The latter case has its counterpart in the "beat cramps" frequently observed in industry, which rarely come to operation and which are not, as a rule, thought of as potential spastic obstructions. Kelly and Pototschnig have each reported a fatal case of spastic ileus, in which no other factor than undigested food or excessive intake could be found at operation or autopsy. Intestinal spasms and intussusceptions in infants may well be on the basis of the ingestion of irritating foods.

*Bleeding into the intestine* The escape of blood into the gastro intestinal tract often

acts as an irritant, as is witnessed by the frequent vomiting and diarrhoea following massive gastro intestinal hemorrhages Jenczel describes spastic ileus following resection of a carcinoma of the colon Laparotomy revealed massive hemorrhage from an overlooked duodenal ulcer, with extreme contraction of the entire small intestine Franke reports two similar cases, one of which was likewise demonstrated at operation

**Ulceration** As mentioned before, decubitus ulceration may be the immediate cause of enterospasm in the presence of foreign bodies or intestinal worms, just as ulcers elsewhere in the alimentary tract often give rise to spasms at their sites Strehl has had a case of ileo cæcal tuberculosis with increasing obstruction At operation, fifteen segments of spastically contracted bowel were seen, corresponding to which were the multiple tuberculous ulcers found at autopsy

**Hernias** One of the most frequently observed local causes of spastic ileus is strangulation in a hernial sac The spasm persists after spontaneous or operative relief and is due, apparently, to damage to the bowel during the period of strangulation Brunzel has observed 3 such cases, 1 of which followed strangulation of an umbilical hernia Similar observations are reported by Barth, Brunn, Melchior, Florack, Reiss, and Kessler Wilms has called attention to the fact that strangulation of a Littre hernia also may be followed by spastic occlusion of the bowel This group of cases suggests that some of the mishaps following taxis or reduction of strangulated hernia may have been due to persisting spasm at the site of strangulation

**Circulatory disturbances** Payr has shown that the injection of solid particles into the mesenteric vessels, producing artificial emboli and local anæmia, causes maximal contraction of the affected portion of bowel and he has reported a case of spastic ileus due to torsion of the omentum with thrombosis of the veins Mueller states that arteriosclerosis of the mesenteric vessels may give rise to enterospasm, and Lecene reports one such case in which no cause other than sclerosis of the vessels supplying the spastic segment of the bowel could be found Some of the cases

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#### REFLEX SPASTIC ILEUS DUE TO DISTANT LESIONS

The occurrence of spastic ileus from intrinsic reflexes as described above is readily understood Less clear are those cases which seem to arise from irritants acting at a distance, the effect of which must be by way of an extrinsic reflex While it is true that most of the control of the motility of the bowel is effected by the myenteric plexus of Auerbach and Meissner, the coeliac and inferior mesenteric plexus, made up of sympathetic and vagus elements, do exert some control Talma demonstrated experimentally that vigorous stimulation of the coeliac ganglion resulted in active motility of the intestine, chiefly in the form of spasmodic contractions There are on record several clinical cases of spastic ileus, which were due to inflammatory or cicatricial processes involving the coeliac plexus Maier and Mosse have demonstrated changes in the coeliac ganglion in experimental lead poisoning, to which they attribute the colics and spasms accompanying this condition Recent observations with regional and spinal anesthesia have given further support to the assumption that irritants at a distance, acting by way of the extrinsic reflexes, may cause spastic ileus Denk states that, with satisfactory injection of the splanchnic plexus (by the Kappis method), he often notices moderate cyanosis and definite spasms of the bowel Wagner found that spinal anesthesia was frequently sufficient to initiate peristalsis in paralytic ileus, and his observations have been confirmed experimentally and clinically by Markowitz and Campbell, and Ochsner, Gage, and Cutting Mayer made similar observations and noted further that spastic ileus could also be relieved by intraspinal anesthesia French surgeons in particular, have adopted spinal anesthesia as a treatment for ileus, and Duval has collected 400 cases in which it has been used Of this number 8 were said to have been cases of spastic ileus, and in every instance the condition was defi-

nately relieved by the spinal injection. The relief of obstructions due to atony and spasm by the same measure would appear scarcely credible, but Colmers explains the apparent contradiction as follows. Normal tonus of the intestine depends upon a balance between the pressor effect of the vagus and the depressor influences of the splanchnics. Should the balance be disturbed by excessive stimuli from either of these systems, interruption of the abnormal impulses by spinal anaesthesia would promptly restore the normal status. Granting that the action of stimuli by way of the vegetative nervous system may lead to the picture of spastic ileus, it will be seen that these stimuli may be direct, acting on the nerves or ganglion cells themselves, or indirect, acting by way of reflex irritation.

*Lesions involving the coeliac plexus.* Exner and Jaeger report a case of spastic ileus due to an inflammatory lesion of the posterior wall of the pylorus, with involvement of the retro-pentoneal nerve plexus. Klett's case was due to carcinoma of the pancreas with retro-pentoneal extension, and Prader's to acute pancreatitis. Koennecke saw two such patients, one with an inflammatory tumor of the pancreas and one with an ulcer which penetrated into the pancreas. Although changes in the coeliac ganglion have been described in experimental lead poisoning, the evidence has been held inadequate to warrant placing the cases of spastic ileus due to plumbism in this group.

*Spastic ileus following contusions to the abdomen.* While spastic ileus occurring after blunt contusions to the abdomen may be the result of injury to the bowel itself, it more often appears to be reflex from trauma to pentoneal surfaces. Several cases of this type are on record. Rehn operated upon a patient 9 hours after a severe contusion, with diagnosis of ruptured bowel. A portion of the sigmoid, corresponding in position to the site of the traumatism, was found contracted down to the diameter of a finger. Beyond this there was nothing, and recovery followed the simple laparotomy. Trendelenburg has opened the abdomen twice, following contusions, to find localized spasm of the bowel. Often the injury which gives rise to the spasm

is not severe. Fromme reports a case in a child, aged 11½ years, who was running on a springy wooden floor, and another in which the patient fell and fractured several ribs. I have seen a case very similar in its etiology to this last one.

**CASE 1.** The patient J. H., a male aged 27 years, fell from a scaffold about 25 feet high while at work on the morning of December 10, 1927. He was admitted to Wesley Hospital about an hour later in a state of moderate shock (blood pressure 60-60) and complaining of pain in the back. The X-ray picture revealed an oblique fracture of the right transverse process of the first lumbar vertebra, all other bony structures being normal. The temperature was subnormal, and the pulse rate was 80. The abdomen was diffusely and uniformly rigid but was neither tender nor painful and there were no external evidences of injury to the abdomen. No neurological findings were elicited. During the ensuing 24 hours the patient recovered from his shock, and the abdominal rigidity relaxed somewhat. About 25 hours after admittance he began to complain of severe intermittent, cramp-like pain referred to the region of the umbilicus which soon became so acute as to cause him to cry out with each paroxysm. Vomiting occurred twice. The pulse rate rose rapidly to 122, and the abdomen became slightly distended but the temperature remained normal. Some of the rigidity was still present and there was very slight tenderness in the right lower quadrant. Peristaltic sounds were increased and vigorous peristaltic waves were heard to accompany the paroxysms of pain. Because of the picture of mechanical ileus the abdomen was opened under nitrous oxide anaesthesia. Exploration of the entire abdominal cavity revealed no evidence whatsoever of trauma. A segment of ileum about 3 feet long was found to be collapsed, empty, and ribbon-like. At either end the collapsed portion merged with normally distended bowel. There was no obstruction or other abnormality at these points. During the manipulation incident to the examination, the contracted segment was seen to relax and resume the appearance and caliber of the rest of the bowel. The abdomen was closed without drainage. On the following day the patient had several paroxysms of abdominal pain which responded readily to opiates, atropin, and external heat. Convalescence was rapid, and there were no other symptoms attributable to his injury or operation.

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ruptured extra uterine pregnancies were closely questioned, and it was thought that a history could be elicited in every instance of pain suggestive of intestinal spasm, following the severe, tearing pain of the rupturing tube. In support of this may be mentioned the experience of Jordan, who operated for ruptured spleen following trauma and found in addition spastic contraction of the sigmoid and half of the small intestine.

*Postoperative spastic ileus* While most functional disturbances of the bowel following operations are paralytic in nature, occasionally true spastic obstructions are encountered. It is difficult to state whether these are due to trauma of the bowel during the laparotomy or to thrombosis of the mesenteric vessels, or whether in certain cases, they may not be due to beginning peritonitis or even to the primary condition for which the operation was performed. It is hard to understand why trauma, which usually gives rise to intestinal paresis or paralysis in these cases produces the opposite reaction. Furthermore, it has often been noted that the manipulation during reoperation has brought about relaxation of the spasm induced by the original operation. Braun and Wortmann state that intestinal spasm and intestinal paralysis may be caused by the same factors, that both may be present simultaneously, and that intestinal paresis may be preceded by a state of spasm. Spastic ileus following operation has been seen with particular frequency after gastric and gynecological procedures. Koerte has observed 6 such cases, 5 of which ensued after gastroenterostomy. I have also seen a case following operation for peptic ulcer.

*CASE 2* The patient A. S., a male aged 46 years, was operated upon for perforating post pyloric ulcer. Resection and retrocolic side to end gastrojejunostomy (Polya) was done. Mobilization of the duodenum was very difficult because of the extensive inflammatory adhesions and considerable soiling occurred requiring the placing of a drain down to the duodenal stump. On the second day symptoms of obstruction appeared which were thought to be due to mechanical block at the site of anastomosis. Reoperation revealed local peritonitis about the stump of the duodenum. The gastrojejunostoma was free and intact. The stomach and proximal half of the small bowel were dilated, the distal half was empty collapsed, and contracted. The point

of transition between the distended and collapsed portions was abrupt and free from any abnormality whatsoever. Jejunostomy was done and the abdomen closed. Death occurred 3 days later and autopsy revealed localized peritonitis as its cause. No statement was made as to the condition of the small bowel at that time.

It is significant that in the cases observed by Koerte, in which spastic ileus followed gastro-enterostomy, several times the spasm was located in the jejunum. We know from the experimental ulcer studies of Mann and his co-workers that the acid contents of the stomach are irritating to the jejunal mucosa. This suggests the possibility that these cases arise frequently after gastric operations because of the local irritating action of the stomach contents on the jejunum, which produces local spasm. This also may explain certain cases of "vicious circle" following gastrojejunal anastomoses, particularly those in which reoperation fails to reveal a mechanical explanation for the accident. The following case may have been illustrative of this occurrence.

*CASE 3* The patient M. F., a male 56 years old, was operated upon for very early carcinoma of the stomach. Partial resection was done with retrocolic end to side gastrojejunal anastomosis (Polya), and an uneventful recovery ensued. The patient, however, complained of fullness as though of gas, in the epigastrium and chest with relief on eructation. X-ray examination 12 days after the operation showed a large fundal portion remaining with a 5 hour residue. Patient left the hospital on the following day, but was compelled to return a week later because of persistent vomiting. Aspiration revealed high grade retention and reoperation was done. No obstruction could be found. The line of anastomosis was completely freed and found entirely satisfactory. Incision was made into the stomach above the anastomosis and a good free opening into both jejunal loops could be demonstrated. The opening was enlarged somewhat and the gastrotomy incision closed. An entero-anastomosis was done just below the gastrojejunostoma and the jejunum was sutured to the colon to insure against invagination. The patient made a slow recovery since convalescence was delayed by the development of a fecal fistula.

In a rather extensive series of currently appearing articles Reischauer has voiced a similar opinion regarding the relation of vicious circle to enterospasm and he has attempted to show, moreover, that most of the

other obstructions following stomach operations have their origin in spasm

*Spastic ileus accompanying lesions of other organs* Those cases of spastic ileus associated with lesions of other intraperitoneal, or even with extra abdominal, structures would seem of necessity to be reflex in origin. One interesting group of this type is that due to mechanical obstruction involving some other bowel segment. Thus Haidenhain, Jenckel, Schlesinger, and Brunn have seen spasms of the small bowel associated with carcinoma of the rectum, Miller's case was associated with mechanical obstruction of another loop of bowel by a band, Barsony's patient had tuberculosis of the cæcum producing spasm in the ileum, and Haidenhain's patient had volvulus. Whether the spasm in these cases is reflex or whether it is due to stagnation of contents above the mechanical obstruction cannot be determined. Franke saw enterospasm during operation for peptic ulcer, Braun and Wortmann saw enterospasm from hydrocele, Mueller from early appendicitis, Brodnitz from adrenal hæmorrhage, Engstad from cystic ovary, and Huguier and Parvu from renal colic.

A word should be said regarding the relationship between intestinal spasm and intussusception. Nothnagel demonstrated experimentally that invagination could be produced by causing local spasm of the bowel by means of faradic stimulation. He believed that clinical intussusception began as enterospasm. This theory has been substantiated by the experiments of Propping and others and by numerous clinical observations. Fromme describes a case in which symptoms persisted after release of an invagination and resulted in the death of the child patient. At autopsy spastic narrowing of the small bowel was seen. In 2 other cases observed by the same author intussusceptions and enterospasms were seen simultaneously, apparently having had a common origin. It would seem therefore, that enterospasm and invagination may arise from the same source and may be present simultaneously. Localized spasm may lead to intussusception, and injury to the bowel during intussusception may determine an enterospasm which may persist after release of the

invagination and may even result in the death of the patient.

#### CAUSES ACTING BY WAY OF THE CENTRAL NERVOUS SYSTEM

Although there is no known "center" for intestinal control in the brain, nevertheless some degree of influence is exerted on the bowel by the central nervous system. This finds expression in the frequently observed emotional diarrhoeas, which, like the vomiting that often accompanies intense psychic stimulation, denote a connection between the cortical centers and the gastro intestinal tract. Spastic ileus has been described accompanying both organic lesions and psychic disturbances. Steindl, as mentioned, found degenerative changes in the medulla of 2 patients who died of postoperative spastic ileus. He believes that there must be a "tendency to spasm" as a prerequisite to the development of enterospasm and attributes the increased irritability to organic changes in the brain stem. So bold an assertion requires wide confirmation beyond the few instances he has described. Schuele has seen enterospasm for which no local cause could be found, and only autopsy several months later revealed a small inflammatory tumor in the floor of the fourth ventricle as a source of the mischief. Spastic ileus has been seen, too, in *tabes dorsalis*, and Deutschlander states that enterospasm frequently occurs in Little's disease. The cases due to lead poisoning might be placed in this group, as might also those observed in influenzal infections.

Much has been written regarding the role of hysteria in the etiology of spastic ileus. Some of the earlier writers have even gone so far as to state that a hysterical background is necessary to the development of such a condition. It would seem that the term hysteria has been rather loosely used in this connection. There are cases, described as hysterical ileus, in which the picture of intestinal obstruction was fictitiously assumed by the patient, even to the swallowing of fecal matter in order that it might later be vomited. These, obviously, have nothing in common with spastic intestinal occlusion. There are other instances in which a history

and stigmata of hysteria are present, but in which there is also some local cause for the enterospasm. Finally, there is the group in which no regional explanation is found, and in which "hysteria" has often been invoked to account for the occurrence. In some of these last mentioned cases, local causes may well have been present though undiscovered. In others, simply increased local or general irritability of the nervous system may have determined the spasm. In none does the term "hysterical" seem justified. We recognize different degrees of irritability in the nervous systems of different persons, and it is to be expected that the most sensitive nervous apparatus is most likely to give exaggerated responses to ordinary stimuli. In its final analysis the matter reduces itself to the relative intensity of the stimulus for the irritability of the affected nervous mechanism.

To sum up, enterospasm is a state of exaggerated contraction of a portion of the intestinal musculature, which leads to obliteration of its lumen and owes its origin to a stimulus that is excessive for the degree of irritability of that particular nervous apparatus. The stimulus giving rise to the spasm may act anywhere in the complicated nervous system supplying the bowel. In some cases the irritability of the local or general nervous mechanism may be so greatly increased that spasms will occur without known extrinsic cause.

#### ANALYSIS OF THE COLLECTED CASES

I have collected from the literature 157 cases of spastic ileus (Table I), in which the findings at operation or autopsy were sufficiently definite to warrant their acceptance, and to this number have added the 2 cases here reported. Of the total 159 cases, 56 occurred in males and 73 in females. In the remaining 30, the sex was not stated. The ages varied from 5 months to 82 years. Three of the patients were infants less than 1 year old and 17 were children under the age of 15 years. The largest number, however, were adults in the middle span of life, 78 of the 129 stated ages falling between 20 and 60. The cause of the enterospasm was either not determined or not stated in 39 cases. In an

other 39 cases the contraction occurred seemingly in response to local or intrinsic causes, in 57 cases the contractions appeared to be reflex, and in the remaining 24 cases they were due to disturbances of the central nervous system.

#### CLINICAL PICTURE

The clinical picture of spastic ileus is the clinical picture of mechanical ileus. Like mechanical obstructions, the spastic occlusion may be acute or chronic, may be high in the small bowel or in the colon, and may be incomplete with mild manifestations or complete with the full stormy picture of bowel obstruction. The phenomena dependent upon strangulation, however, are absent. Only one difference in the manifestations of spastic and organic occlusions has been encountered with any degree of consistency, the general condition of patients having functional obstructions is good as compared with that of patients having mechanical ileus. Furthermore spastic obstructions are much more apt to be intermittent and to subside spontaneously. It must not be inferred from this, however, that a differentiation on this basis is clinically possible. Cases of enterospasm are reported in which the patients presented the picture of serious collapse, and death has not infrequently occurred from purely spastic occlusions.

The onset of symptoms may be gradual or abrupt. The patients usually complain of severe, cramp-like pain, vomiting and obstipation. Tympanites may or may not be present. If the case is seen early, no dilatation of the proximal bowel is found, if seen late, the abdomen may be ballooned as in neglected mechanical obstructions. Similarly, if the spasm is high in the alimentary tract, there will be no distention, if it is low, abdominal distention may occur. Furthermore if the major portion of the bowel is involved and is spastic and contracted the abdomen may be scaphoid rather than distended.

Hardenham called attention to a bradycardia in his cases and several subsequent authors have observed a similar symptom. This has been attributed to vagal irritation and has been considered by some to be of diag-

nostic value. It is very inconstant, however, for many cases with a marked tachycardia, rather than with a slowing of the pulse rate, have been described. In the cases which I have reported there was no noticeable slowing of the heart rate. In the first the pulse rate rose rapidly as the symptoms of ileus developed. In the second case definite tachycardia prevailed.

The diagnosis of spastic ileus cannot be made before the abdomen is opened. There are no criteria by which a given case of ileus may be definitely adjudged spasmodic, and attempts to do so which lead to delay in operation should be avoided. At laparotomy the diagnosis of spastic ileus is permissible when spasm of the bowel is demonstrated and when there is no mechanical cause for the obstruction.

The findings at operation vary considerably, but, in general, three types of contractions have been found. The most frequent condition is a spasm of one or more segments of considerable length, varying from a few inches to a number of feet. In some instances the entire small bowel has been compromised. The affected portion is usually described as being empty, pale or mottled in color, of increased consistency, and resembling tape or ribbon or having the caliber of a pencil, of rope, or of a finger. The second type of contraction is a ring like furrow, "as if a string had been tied around the gut." In a few instances multiple, transient spasms, moving from place to place along the course of the bowel, have been encountered.

The prognosis of spastic ileus, in the uncomplicated case, is said to be good. Nevertheless, death has not infrequently resulted. In the 159 collected cases, 102 patients recovered, 47 died, and the outcome in the remaining 10 was not stated. This constitutes a mortality rate of 31.6 per cent in those cases in which the outcome is given. Of this number, however, 9 (6.2 per cent) presented spastic ileus as a more or less incidental finding and not directly as a factor in the cause of death. Thus, in 2 cases death resulted from uræmia and in 1 case each from meningitis, encephalitis, brain tumor, retroperitoneal phlegmon due to carcinoma of the rectum,

TABLE I—ETIOLOGY AND MORTALITY IN ONE HUNDRED AND FIFTY-NINE CASES CONFIRMED BY OPERATION OR AUTOPSY

Cause of enterospasm	Recovered	Deaths	Not stated	Total
<b>Local causes</b>				
Foreign bodies	3	3		6
Intestinal worms	13	2	1	15
Irritating foods	3	2		5
Bleeding into bowel		1		1
Strangulated hernias	7	3		10
Ulceration	1	1		2
Circulatory disturbances		1		1
<b>Reflex causes (by way of celiac and inferior mesenteric plexus)</b>				
Lesions involving celiac plexus	0	4		4
Cutaneous of abdomen and adjacent areas	0	1		1
Postoperative spastic ileus	14	11	3	28
Lesions of other organs	11	5	2	18
Intussusception		1		1
<b>Causes acting by way of central nervous system</b>				
Hysteria	10	2		12
Grippe	4	2		6
Uremia	1	2		3
Lead poisoning	2			2
Brain tumor	1			1
Cause not determined or not stated.	56	7	6	69
<b>Totals</b>	<b>102</b>	<b>47</b>	<b>10</b>	<b>159</b>

pulmonary embolism following rib fracture, pneumonia after operation for intussusception, and ileocolostomy for intestinal tuberculosis. In 19 additional patients (12.8 per cent) it was a contributory factor but not the sole cause of death. Many of the post-operative cases fall into this group. In the remaining 20 lethal cases no other cause of death was found, and in these the fatality must be attributed directly to the enterospasm. Of the patients who did not succumb to the disease, there were some who were not cured. Although the subsequent history of most of these persons is not stated, in 14 (14 per cent) symptoms recurred after operation. Some of this group responded to medical treatment, others submitted to repeated operations, and in several the condition apparently persisted indefinitely, in spite of all treatment. From this review, it is seen that spastic ileus, while apparently offering a good prognosis in uncomplicated cases, has been associated with a very considerable mortality and persistent morbidity in the entire series.

The treatment of spastic ileus is essentially surgical. If it were possible to make a positive pre-operative diagnosis of enterospasm, temporizing with conservative measures, such as the use of morphine, atropine, and external heat, would be justified. Inasmuch as the diagnosis cannot be made with certainty, however, every bowel obstruction must be considered

organic in nature until proven otherwise. Surgery must, therefore, remain the treatment of choice. What is done when the abdomen has been opened will depend somewhat on the cause of the spasm and the condition of the patient. As has been stated, usually the manipulation incident to the laparotomy has sufficed to bring about relaxation of the contraction. If the cause of the ileus can be corrected at the same time, this should, of course, be done. In the occasional case, in which the condition of the patient is seriously impaired by long standing obstruction, enterostomy may be advisable. Amberger strongly urges enterostomy in every case of spastic ileus, feeling that one of his patients might have been saved had this been done. In those instances in which the spasm is not due to purely local factors, there is no assurance that it will not recur in other places after enterostomy at the site of the original contraction has been done. Resection or entero anastomosis hardly seem indicated for obstructions of spastic origin. After the diagnosis has been definitely established at operation, further postoperative treatment with sedatives, antispasmodics, and external heat should be carried out. It must be remembered that operation for the relief of a spastic bowel occlusion may in turn give rise to a mechanical obstruction which can be alleviated only by a second operation.

#### SUMMARY

Spastic ileus is a form of intestinal obstruction the origin of which depends upon a persisting contracture of the musculature of the bowel, leading to obliteration of its lumen. The spasm producing the occlusion is usually of nervous origin and is due to a stimulus which is excessive for the degree of irritability of the local or general nervous apparatus involved. The impulse may arise in any portion of the complex nervous mechanism controlling the motor function of the bowel. The cases therefore, fall into three groups corresponding to the three major divisions of the nerve supply to the intestinal tract. Thus we see spasms from irritants acting locally at the site of spasm, by way of the intrinsic nervous plexus, reflex spasms, through the coeliac and

inferior mesenteric plexus, from lesions distant from the spastic bowel segment, and those enterospasms arising from organic or functional disturbances of the central nervous system. If the local or general nervous irritability is sufficiently increased, excessive contraction may result from physiological stimuli, and no extrinsic cause for the spasm may be found. The clinical picture in spastic ileus is the same as that in mechanical obstructions, except that intermittency and spontaneous recovery are more apt to occur, and the general condition of the patient is usually less seriously impaired. The diagnosis cannot be definitely made except at operation, and is then acceptable only when the spasm is demonstrated and no organic obstruction is found. Treatment is essentially surgical in most cases responding to simple laparotomy. The prognosis is said to be good in uncomplicated cases, although, in the series of 159 cases analyzed, there has been a considerable mortality and a number of the patients have continued to have symptoms in spite of all types of treatment.

#### BIBLIOGRAPHY

- AMBERGER. Zur Operation des spastischen Ileus. *Zentralbl. f. Chir.* 1921 xlii 1262.  
 ASKE. Notes on a case of enterospasm. *Brit. M. J.* 1907 1 452.  
 ASTERIADES. Sur le traitement de l'Ileus Spasmodique. *Post-opératoire Aigu par la simple Rachianesthésie*. Presse méd. 1915 xxxiii 1480.  
 BANZEY. Occlusions Intestinales spasmodiques. *Arch. de mal. de l'appar. digest.* 1923 xiii 122.  
 BARSONY. Ileum-pasmus bei einem Coecumprolaps. *Arch. f. Verdauungskr.* 1923 xxxi 245.  
 BARTH. Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxxviii 263.  
 BECK. Zentralbl. f. Chir. 1913 xl 179.  
 BEHRING and KLERCKER. Hirschsprung's disease caused by spasm. *Acta paediat.* 1914 October.  
 BERTHELMANN. Zentralbl. f. Chir. 1908 xl 119.  
 BIERNATH. Präparat eines Falles von Ileus durch spastische Darmstenose. *Deutsche med. Wchnschr.* 1913 xxxix 2380.  
 BRAUN and WORTMANN. Der Darmverschluss. Berlin 1924.  
 BRODITZ. Die Apoplexie der Nehenere. *Verhandl. d. deutsch. Gesellsch. f. Chir.* 1910 xxxix 280.  
 BURN. Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxxviii 262.  
 BRUNZEL. Ueber das Fortbestehen von Okklusionssymptomen trotz erfolgreicher Beseitigung kurzdauernder Bruchinklemmung. *Deutsche Ztschr. f. Chir.* 1917 cxi 206.  
 Idem. Ueber einen Fall von chronischen in Attacken auftretenden spastischen Ileus bei einer schwer nervös belasteten Patientin. *Deutsche Ztschr. f. Chir.* 1919 cxliii 414.

- BUNGE Ueber postoperativen spastischen Darmverschluss Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxxv 258
- BUTNER. A case of spasmodic ileus in an infant simulating intussusception J. Am. M. Ass. 1914 lxv 1391
- CHENESSE L. Ileus spasmodique et l'enterospasme chronique Semaine méd. 1910 xxx 301
- COLMER Ueber spastischen Ileus Muenchen med. Wehnschr. 1926 lxxvii, 2205
- DAX Ueber hysterischen Ileus Beitr. z. klin. Chir. 1910 lxx 330
- DEAN A case in which enterospasm was a pronounced feature necessitating abdominal section 4 times within 10 months Brit. M. J., 1909 March 647
- DEYK Erfahrungen mit der Kapsischen Splanchnikusanästhesie Wien klin. Wehnschr. 1919 xxxv 999
- DIMITRIEFF Ileus verminosus Zentralbl. f. Chir. 1926 lxx 1876
- DUVAL La rachianesthésie dans l'ileus aigu Bull. et mém. Soc. nat. de Chir. 1927 lvi 596
- EDELMANN Spastischer Ileus Appendicitis und Darmgrippe Zentralbl. f. Chir. 1928 lv 75
- ENGSTAD Spastic paralysis of the jejunum J. Am. M. Ass. 1928 xc, 2003
- EYNER und JAEGER Zur Kenntnis der Funktion des Ganglion coeliacum Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1909 xi 645
- FALLS Enterospasme Brit. M. J. 1906 i 318
- FLOORACK Beitrag zum spastischen Ileus Deutsche Ztschr. f. Chir. 1924 clxxv 289
- FRANKER Zur Erklärung des postoperativen spastischen Darmverschlusses Zentralbl. f. Chir., 1908 xxiv 1203
- Idem. Heuseracheinungen bei akuter Magenblutung Deutsche med. Wehnschr. 1923 No. 43 p. 1368
- FREEMAN Spastic ileus Ann. Surg. 1918 lxxvii 196
- FAWCEZ Ueber spastischen Ileus Deutsche med. Wehnschr., 1914 xl 1010
- Idem. Ueber Darmnagelungen und spastischen Ileus Deutsche Ztschr. f. Chir. 1914 clxxv 579
- HABES Intestinal spasm due to ascans lumbicoides Brit. M. J. 1923 v 1151
- HEDENHAIN Beiträge zur Pathologie des akuten Darmverschlusses Verhandl. d. Deutsch. Gesellsch. f. Chir. 1897 xxvi 117
- HARKINS The reality of enterospasm and its mimicry of appendicitis Brit. M. J. 1906 i 65
- HENSEL Spastischer Ileus bei Lungenembolie Zentralbl. f. Chir. 1928 lv 1094
- HUGUET und PARVU Occlusion intestinale spasmodique constatée par laparotomie symptomatique d'une crise de coliques néphrétiques Paris chir. 1913 v 682
- I. RAEL. Einige Beobachtungen an Ileusfaellen Berl. klin. Wehnschr. 1892 xxix 4
- JACOBSEN Spastic ileus Hosp. Tid. 1922 lxx 753 Abstracted in J. Am. M. Ass. 1923 lxxx 150
- JENCKEL Zentralbl. f. Chir. 1923 l 644
- JORDAN Ueber die subkutane Milzzerreissung und ihre operative Behandlung Muenchen med. Wehnschr. 1909 xlvii 94
- KAISER Darmverschlussercheinungen durch retroperitoneale Haematome Muenchen med. Wehnschr. 1921 lxxvii 805
- KATSEN Beiträge zur Hysterie in der Chirurgie Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1907 xvii 469
- KELLY Enterospasme und intestinal obstruction Brit. M. J. 1906 i 977
- KESLER Spastischer Ileus mit doppelseitiger inkarzierter Cruralhernie Deutsche Ztschr. f. Chir. 1923 clxxix 207
- KIESELBACH Ein Fall von Enterospasmo verminosus geheilt durch Enterotomie Beitr. f. klin. Chir. 1911, lxxvi 204
- KLETT Ueber spastischen Ileus Zentralbl. f. Chir. 1923 l 644
- KOENNECKE Spastischer Ileus Muenchen med. Wehnschr. 1923 lxx 981
- KOERT Ueber den Darmverschluss durch Gallensteinen Arch. f. klin. Chir. 1893 xlvii 331
- Idem. Erfahrungen ueber Enterospasmus Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1924 xxvii 211
- KOESTER Ueber einen besonderen Fall von Ileus spasticus invaginatus auf rein psychogener Grundlage Med. Klin. 1927 xxvii 205
- KUESTER Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxvii 266
- LANGEMAK Spastischer Erkrankungen des Magendarmtrakts Zentralbl. f. d. Grenzgeb. d. Med. u. Chir., 1902 v 474
- LEUNE Ueber Ileus spasticus Muenchen med. Wehnschr. 1898 xlv 1321
- MARKOWITZ und CAMPBELL The relief of experimental ileus by spinal anesthesia Am. J. Physiol. 1927 lxxvii 101
- MASSARY Chirurgische Vorkommnisse waehrend der mit Encephalitis choreiformis kombinierten Grippepidemie Muenchen med. Wehnschr. 1920 lxxvii 389
- MATHEWS Enterospasme causing intestinal obstruction Northwest Med. 1915 vii 282
- MAYER Ueber die Wirkung der Lumbalanästhesie auf die glatte Muskulatur Deutsche med. Wehnschr. 1921 1454
- Idem. Ueber abnorme Kontraktionsphaenomene am Darm Zentralbl. f. Chir. 1921 1622
- MELCHIOR Enterospasmus als Ursache persistierender Darmverschluss nach behobenen Bruchinklemmung Klin. Wehnschr. 1923 v 1940
- MENDESNAUSEN und KOEHN Colospasmus und spastischer Ileus im Anschluss an Grippe Med. Klin. 1926 xxi 2025
- MURPHY Ileus J. Am. M. Ass. 1896 xxvi, 15 72
- NAGEL Zur Kenntnis des spastischen Ileus Beitr. f. klin. Chir. 1921 clxxv 139
- NEUGEBAUER Spastische Obstipation und Volvulus Med. Klin. 1919 xv 265
- NORDMANN Hystischer und spastischer Darmverschluss Deutsche med. Wehnschr. 1910 clxxvi 452
- Idem. Zentralbl. f. Chir. 1923 l 1297
- NOTHNAGEL Diseases of the Intestines and Peritoneum Nothnagel's Practice Philadelphia W. B. Saunders Company 1904
- PANLOW Ueber einen Fall von spastischen Ileus Muenchen med. Wehnschr. 1903 l 1962
- PAYR Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxvii 266
- PENDREB Enterospasme operation death. Brit. M. J., 1909 i 1292
- POTOTSCHNIK Ueber spastischen Ileus Deutsche Ztschr. f. Chir. 1920 cliv 303
- PRADER Spastischer Ileus bei Pankreatitis akuta Med. Klin. 1920 xvi 695
- PROPPING Ueber den Mechanismus der Darminvagination Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1910 xxi 536
- QUÉNU La rachianesthésie dans le traitement des occlusions intestinales aiguës ses indications ses résultats. Bull. et mém. Soc. nat. de chir. 1927 lvi 160
- REHN Verhandl. d. deutsch. Gesellsch. f. Chir., 1900 xxx 105
- REIMER Spastischer Darmverschluss bei intraperitonealen Blutungen Arch. f. klin. Chir. 1925 clxxv 520

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#### BIBLIOGRAPHY

- AMBERGER Zur Operation des spastischen Ileus Zentralbl. f. Chir. 1922 xlii 2162  
 ASKE Notes on a case of enterospasm. Brit. M. J. 1907 i 482  
 ASTERIADES Sur le traitement de l'Ileus Spasmodique Post-opératoire Aigu par la simple Rachianesthésie Presse méd. 1925 xxxiii 1280  
 BANZET Occlusions Intestinales spasmodiques Arch. de mal. de l'app. digest. 1923 xlii 222  
 BARSOV Ileus spasmus bei einem Coecumprolapse Arch. f. Verdauungskr. 1923 xxxi 245  
 BARTH Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxxviii 263  
 BECK Zentralbl. f. Chir. 1913 xl 1779  
 BEHRING and KLECKER Hirschsprung's disease caused by spasm. Acta paediat. 1924 October  
 BERTHELMANN Zentralbl. f. Chir. 1908 xl 1779  
 BIERNATH Präparat eines Falles von Ileus durch spastische Darmstenose Deutsche med. Wchnschr. 1913 xxxix 2380  
 BRAUN and WORMANN Der Darmverschluss Berlin 1924  
 BROVITZ Die Apoplexie der Nebenniere Verhandl. d. deutsch. Gesellsch. f. Chir. 1910 xxxix 230  
 BRUNN Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 xxxviii 262  
 BRUNZEL Ueber das Fortbestehen von Okklusionssymptomen trotz erfolgreicher Beseitigung kurzdauernder Bruchinklemmung Deutsche Ztschr. f. Chir. 1917 cxl 206  
 IDEM Ueber einen Fall von chronischen in Attacken auftretenden spastischen Ileus bei einer schwer nervös belasteten Patientin Deutsche Ztschr. f. Chir. 1919 cxlii 474

- BOYGE Ueber postoperativen spastischen Darmverschluss Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 lxxviii 258
- BUTZNER A case of spasmodic ileus in an infant simulating intussusception J. Am. M. Ass. 1914 lxi 1391
- CHERNESSE L. Ileus spasmodique et l'enterospasme chronique Semaine méd. 1910 xxx 307
- COLMEAS Ueber spastischen Ileus Muenchen med. Wchnschr. 1926 lxxvii 2105
- DAY Ueber hysterischen Ileus Beitr. z. klin. Chir. 1910 lxx 330
- DEAN A case in which enterospasm was a pronounced feature necessitating abdominal section 4 times within 10 months Brit. M. J., 1909 March 647
- DENK. Erfahrungen mit der Kapsischen Splanchnikusanästhesie Wien. klin. Wchnschr. 1919 xxxii 099
- DUMITREY Ileus verminosus Zentralbl. f. Chir. 1926 lvi 1876
- DUVAL La rachianesthésie dans l'ileus aigu Bull. et mém. Soc. nat. de Chir. 1927 lvi 596
- EDELMAVY Spastischer Ileus Appendicitis und Darmgrippe Zentralbl. f. Chir. 1928, lv 75
- ENGSTAD Spastic paralysis of the jejunum. J. Am. M. Ass. 1928 xc 2003
- ENVER und JAEGER. Zur Kenntnis der Funktion des Ganglion coeliacum Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1909 xx 645
- FALLS Enterospasme Brit. M. J. 1906 i 318
- FLORACK. Beitrag zum spastischen Ileus Deutsche Ztschr. f. Chir. 1924 cxxxv 289
- FRANK. Zur Erklärung des postoperativen spastischen Darmverschlusses Zentralbl. f. Chir. 1908 xxxv 193
- Idem. Heuserscheinungen bei akuter Magenblutung Deutsche med. Wchnschr. 1913 No. 43 p. 1368
- FRANKEN Spastischer Ileus Ann. Surg. 1918 lxxvii 196
- FROMMELT Ueber spastischen Ileus Deutsche med. Wchnschr. 1914 xl 1010
- Idem. Ueber Darmvaginationsen und spastischen Ileus Deutsche Ztschr. f. Chir. 1914 cxxvi 579
- HARRIS Intestinal spasm due to ascaris lumbricoides Brit. M. J. 1923 ii 1151
- HEIDENHAIN Beiträge zur Pathologie des akuten Darmverschlusses Verhandl. d. Deutsch. Gesellsch. f. Chir. 1897 xxvi 117
- HAWKINS. The reality of enterospasm and its mimicry of appendicitis Brit. M. J. 1906 i 65
- HEYLE Spastischer Ileus bei Lungenembolie Zentralbl. f. Chir. 1928 lv 1004
- HUGUEN und PARVE Occlusion intestinale spasmodique constatée par laparotomie symptomatique d'une crise de coliques néphrétiques Paris. chir. 1913 v 682
- ISRAEL. Einige Beobachtungen an Ileusfällen Berl. klin. Wchnschr. 1897 xxx 4
- JACOBSEN Spastischer Ileus Hosp. Tid. 1922 lxx 753
- Abstracted in J. Am. M. Ass. 1923 lxxx 150
- JACKEL Zentralbl. f. Chir. 1923 i 644
- JORDA. Ueber die subkutane Milzzerreissung und ihre operative Behandlung Muenchen med. Wchnschr. 1901 xlviii 94
- KAISER Darmverschlussercheinungen durch retroperitoneale Hämatome Muenchen med. Wchnschr. 1921 lxxvii 805
- KAVSEN. Beiträge zur Hysterie in der Chirurgie Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1907 xvii 469
- KELLY Enterospasme und intestinal obstruction Brit. M. J. 1906 i 977
- KESLER Spastischer Ileus mit doppelseitigen inkarzierten Cruraethermie Deutsche Ztschr. f. Chir. 1923 cxxx 207
- KIESELBACH Ein Fall von Enterospasmus verminosus geheilt durch Enterotomie Beitr. f. klin. Chir. 1911 lxxvi 204
- KLETT Ueber spastischen Ileus Zentralbl. f. Chir. 1923 i 644
- KOENNECKE Spastischer Ileus Muenchen med. Wchnschr. 1923 lxx 981
- KOERTZ Ueber den Darmverschluss durch Gallensteinen Arch. f. klin. Chir. 1893 xlii 331
- Idem. Erfahrungen ueber Enterospasmus Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1924 xxxvii 211
- KOESSER Ueber einen besonderen Fall von Ileus spasticus invaginatus auf rein psychogener Grundlage Med. Klin. 1927 xxiii 205
- KUESTER Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 lxxvii 266
- LANGEMAK. Spastischer Erkrankungen des Magendarmtrakts Zentralbl. f. d. Grenzgeb. d. Med. u. Chir. 1907 v 4, 4
- LEUBE Ueber Ileus spasticus Muenchen med. Wchnschr. 1898 xlv 1321
- MARKOWITZ und CAMPBELL. The relief of experimental ileus by spinal anesthesia Am. J. Physiol. 1927 lxxxi 101
- MASSARY Chirurgische Vorkommnisse waehrend der mit Encephalitis choreiformis kombinierten Grippeepidemie Muenchen med. Wchnschr. 1920 lxxv 389
- MATHEWS Enterospasme causing intestinal obstruction Northwest Med. 1915 vii 282
- MAYER. Ueber die Wirkung der Lumbalanästhesie auf die glatte Muskulatur Deutsche med. Wchnschr. 1921 1454
- Idem. Ueber abnorme Kontraktionsphaenomene am Darm Zentralbl. f. Chir. 1921 1622
- MELCHIOR Enterospasme als Ursache persistierender Darmverschluss nach behobenen Bruchhinklemmung Klin. Wchnschr. 1923 v 1940
- MENDERSHAUSEN und KOEHN Colospasmus und spastischer Ileus im Anschluss an Grippe Med. Klin. 1926 xlii 2025
- MURPHY Ileus J. Am. M. Ass. 1896 xvi, 15 72
- NAGEL Zur Kenntnis des spastischen Ileus Beitr. f. klin. Chir. 1921 cxxiv 139
- NELGEBACHT Spastische Obstipation und Volvulus Med. Klin. 1910 xv 265
- NORDMANN Hysterischer und spastischer Darmverschluss Deutsche med. Wchnschr. 1910 xxxvi 452
- Idem. Zentralbl. f. Chir. 1923 i 1297
- NOTENAGEL Diseases of the Intestines and Peritoneum Notes on the Practice Philadelphia W. B. Saunders Company 1904
- PANLOW Ueber einen Fall von spastischen Ileus Muenchen med. Wchnschr. 1903 i 1962
- PAYR Verhandl. d. deutsch. Gesellsch. f. Chir. 1908 lxxvii 266
- PENDERB Enterospasme operation death Brit. M. J. 1909 i 1292
- POTOTSCHNIK Ueber spastischen Ileus Deutsche Ztschr. f. Chir. 1920 cliv 303
- PRADER Spastischer Ileus bei Pankreatitis akuta Med. Klin. 1920 xvi 696
- PROFFING Ueber den Mechanismus der Darmvaginations Mitt. a. d. Grenzgeb. d. Med. u. Chir. 1910 xxi 536
- QUEF. La rachianesthésie dans le traitement des occlusions intestinales aiguës ses indications ses résultats Bull. et mém. Soc. nat. de Chir. 1927 lvi 169
- REHN Verhandl. d. deutsch. Gesellsch. f. Chir. 1900 lxxv 105
- REIMER Spastischer Darmverschluss bei intraperitonealen Blutungen Arch. f. klin. Chir. 1923 cxxxv 520



- REISCHAUER Zur Frage der postoperativen Passagestörungen des Magens Beitr z klin Chir 1928 cxlv 639 1928 cxlv 229 1929 cxlv 397, 1929 cxlv 140
- RIEDEL Der Mechanismus der Darminstülpung bei einem Kinde mit drei Invaginationen Mitt a d Grenzgeb d Med u Chir 1905 xiv 218
- RIESS Zur Aetiologie des spastischen Ileus Zentralbl f Chir 1915 li 2758
- RYNE Zwei Fälle von schweren chronischen Enterospasmus Arch f Verdauungskr 1909, xv 604
- RITTER Zur Aetiologie des spastischen Ileus und spastischer Darmzustände Zentralbl f Chir 1925 li 309
- ROST Experimentelles und klinisches ueber Askanden ileus Muenchen med Wchnschr 1919 lvi 1066
- Idem Ueber Askandenileus Klinischer und experimenteller Beitrag Deutsche Ztschr f Chir 1919 cl 251
- SCHLOFFER Ueber Ileus bei Hysterie Beitr f klin Chir 1899 xiv 391
- SCHMIEDER Ueber die chirurgische Erscheinungsformen der Grippe Muenchen med Wchnschr 1919 lvi 229
- SCHUELE Spastischer Ileus bei Tumor des IV Ventrikels Arch f Verdauungskr 1925 xii, 2, 7
- SCHULNOF Akuter Darmverschluss hervorgerufen durch Ascaris lumbricoides Muenchen med Wchnschr 1903 l 1035
- SOHN Zur Kenntnis des spastischen Ileus Beitr f klin Chir 1920 cxx 45
- Idem Ueber spastischen Ileus. Deutsche Ztschr f Chir., 1911 cxiv, 218
- STEINOL Neue Gesichtspunkte zum Problem des Enterospasmus Arch. f klin. Chir 1926 cxxx 245
- STREHL Ein Fall von funfzehnfacher zum Theil spastisch-entzündlich Darmstenose tuberculoösen Ursprungs Deutsche Ztschr f Chir, 1898 l 411
- STAUDEN Ueber spastischen Ileus Inaugural Dissertation Bonn 1925 Abstracted in Zentralbl f Chir 1926 li 820
- TREDELENBURG Ueber Milzextirpation wegen Zerreissung der Milz durch stumpfe Gewalt. Deutsche med. Wchnschr 1899 xxv 673
- VOCAL Beiträge zur Pathogenese des Ileus. Wien. klin. Wchnschr 1914 xxv 887
- VORSCHUTZ Zentralbl f Chir 1923 li 310
- WEMMERS Ueber den spastischen Ileus. Muenchen. med. Wchnschr 1910 lvi 983
- WILMS Der Ileus Stuttgart 1906
- WOHLGEMUTH Ueber spastisch hysterischen Ileus Zentralbl f Chir 1913 l 594
- WOELFEL and LIEBLEN Die Fremdkörper des Magens Darmkanals des Menschen. Deutsche Chir. Lieferung, 46 B p 1909
- WYNN and STURM A case of entero-pasm simulating acute obstruction Brit. M J 1909 ii 515

# CLINICAL SURGERY

FROM ST. STEPHEN'S HOSPITAL, BUDAPEST

## OPERATION FOR CARCINOMA OF THE SIGMOID<sup>1</sup>

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### DANGERS AND COMPLICATIONS

**I**NSECURITY of the suture line is the principal danger in operations upon the sigmoid and other portions of the large bowel. Suture of the large intestine is much more difficult than that of the small intestine because of its wide mesenteric attachment and its fatty appendages. In addition, the large intestine is thinner and has a poorer blood supply. The presence of dry, hard fecal masses in the large intestine is another unfavorable factor because on the one hand their presence hinders the rapid passage of the contents and on the other, it adds to the mechanical injury of the suture line. All these difficulties are magnified many times in the presence of obstruction, the usual complication of sigmoid cancer. In these cases the bowel cannot be properly evacuated before the operation, and the retention of fecal matter further adds to the infectiveness of the bowel contents. This together with the great difference in the lumen of the bowel above and below the site of obstruction constitute additional difficulties and hazards in operative work. When total obstruction is present the bowel becomes enormously distended with gas and fluid contents. The bowel wall though apparently intact is permeable to bacteria, it is friable and tears easily. The resistance of the patient is lowered by the stercoræmia.

In operative work upon sigmoid cancer, attention should be paid to the question of fecal load in the bowel. In the presence of a complete obstruction the radical removal of the tumor is postponed until a more favorable moment. One must in the meanwhile be content with creation of a temporary fistula. This is best made in the cæcum so as not to interfere with subsequent procedures. There is no objection to a primary end-to-end anastomosis after resection, provided the bowel has been thoroughly cleansed before the operation. For the cases which lie between these two extremes, in other words for cases in

which a complete evacuation cannot be obtained, the two-stage Mikulicz procedure is preferable. The resection here is completed by formation of a fistula which is closed at a later date.

The location and the extent of the cancerous growth is another consideration to keep in mind. We shall consider as typical sigmoid cancers those growths which are located at the summit of the sigmoid coil or close to it, or at any rate, tumors so located that after their removal an end to end anastomosis without undue tension is possible. In view of the difficulties inherent to colon suture, even the slightest tension must be avoided. It can compromise the end-to-end suture as well as the double barrel stent formation of the Mikulicz operation. For these reasons growths involving either the descending colon or the abdominal portion of the rectum present especial difficulties and do not lend themselves to the same operative procedures as do cancers of the sigmoid proper. In cases of carcinoma involving the transition to the descending colon the best procedure is to resect the entire descending colon, the splenic flexure, and the aboral half of the transverse colon, and to restore the continuity by an anastomosis of the mobile portion of the transverse colon to the sigmoid. Cancers which extend downward to involve the rectum are best attacked by the abdominosacral route. However, we shall here consider those cases only which are limited to the mobile portion of the sigmoid bowel, and which are amenable to resection and to end-to-end anastomosis without undue tension.

The previously mentioned danger of suture line insecurity together with the handling of the distended bowel in obstructive cases resulted in peritonitis which was responsible for the terrific mortality record of the older literature. This complication can be to a great extent eliminated by the proper choice of the time of resection, by the proper choice of the site and extent of resection, by the proper method of closure of bowel

<sup>1</sup>Translated by George Halpern, M.D., Chicago

stumps, and above all, by the introduction of the method of extraperitoneal fixation of the suture line after resection. This method however, is not applicable in most localizations of the cancer of the large intestine. Tumors of the cæcum, of the ascending colon, of the hepatic flexure, and of the proximal portion of the transverse colon preclude the use of this method. They are best treated by a blind closure of the colonic stump and the implantation of the small intestine into the transverse colon end to side. Neither is the method of extraperitoneal transposition of the stump to be recommended in operations on tumors involving the transverse colon. It may lead to angulation or, as I saw it in one case, to strangulation of a loop of the small intestine over the transverse colon which was fixed to the abdominal wall. On the other hand, the method is applicable both in cases of carcinoma of the splenic flexure and of the descending colon in which a circular anastomosis between the sigmoid and the transverse colon can be made after resection and in carcinomata of the sigmoid itself. In the last mentioned group one need not fear angulation or undue tension. The use of the method insures against the grave consequences of a leaky suture line. It is readily conceded that drainage in the vicinity of the suture line endangers its security perhaps to a great extent it may be responsible for its insufficiency. On the other hand however it mitigates against its very danger and renders the operative procedure safe.

The second grave danger is that of recurrence. In the absence of mesenteric involvement and in the absence of invasion of neighboring tissue this danger is relatively not great. Generally speaking lymph node liver peritoneal and bone metastases are much more rarely seen than, for example, in gastric cancer. In every case resection of the bowel should be carried out as far away from the seat of growth as possible, and in the event of mesenteric and lymph node involvement, the latter should be widely excised. Demonstrable involvement of mesenteric lymph nodes seriously compromises the prognosis.

#### PREPARATION OF THE PATIENT

Thorough cleansing of the bowel is the principal point in the preparation of the patient. This of course, is possible only in cases not complicated by high grade obstruction. Cases with complete or almost complete obstruction are treated by a preliminary cecal fistula formation. The use of cathartics in high grade obstruction is contraindicated. It causes exacerbation of the colic like pains and may lead to much graver consequences,

such as complete obstruction or rupture of a decubitus ulcer in the bowel wall above the obstruction. When passage of flatus and feces is not interfered with, medicinal treatment is indicated. Castor oil in a single massive dose of 30 grams can be given 2 or 3 days before the operation and if necessary may be repeated on successive days. One should however, guard against exhausting the patient by heroic purgation. The patient should receive a fluid diet spare in residue and rich in nourishment. It is wise to postpone the operation for a few days if the patient appears to be exhausted by the purgation. Proper results can be accomplished by rest, by proper diet enemas and laxatives. Catharsis should be finished not less than 24 hours before the operation. A tepid water enema is given on the eve before. I consider the use of opiates both before and after operation superfluous in some respects even injurious. On the eve of operation the patient receives a mild hypnotic. All nourishment and fluids are withdrawn 6 hours before the operation and morphine in a dose of 1 to 3 centigrams, according to the size and condition of the patient, is given one half hour before the operation. If a fecal fistula is present it is utilized for washing out the bowel.

#### ANÆSTHESIA

I prefer ether anesthesia induced by ethyl chloride. The operation however, can be done under local anesthesia especially in cases with a freely movable tumor perhaps with a very short general anesthesia during the search for the sigmoid. In difficult cases requiring freeing of adhesions removal of organs such as the small intestine the ovary, the uterus requiring dissection from the posterior abdominal wall or resection beyond the limits of the sigmoid a general anesthesia is necessary. When an objection to general anesthesia exists, these difficult cases may be operated upon under an extensive left sided paravertebral anesthesia.

#### TECHNIQUE

**Position.** A dorsal recumbent position with a high pad under the buttocks is used. The tail end of the operating table is markedly elevated. The operator stands on the left, while the two assistants stand on the right side of the patient.

**Isolation of the operative field.** Two large towels are placed transversely one over the symphysis so as to cover the thighs, the other across the abdomen its lower edge reaching the level of the umbilicus. Two smaller towels are placed obliquely so as to create a rhomboid the long axis of which corresponds to Poupart's ligament and the crest of the ilium.

*Incision of the abdominal wall* The incision begins four finger breadths lateral to the anterior superior spine of the ilium and parallel to Poupart's ligament and is continued in a medial direction as far as the edge of the rectus muscle. The incision is carried down to the aponeurosis of the external oblique, and subcutaneous veins and small spurting arteries are ligated. The external oblique is split in the direction of the incision while the internal oblique and the transversalis muscles are split in the direction of their fibers and are forcibly retracted with blunt retractors. The peritoneum is split parallel to Poupart's ligament. The muscular incision can be made more ample by prolonging it backward into the fleshy portion of the internal oblique and by carrying the incision of the aponeurosis of the external oblique into the sheath of the rectus muscle. The approach is thus made much easier. Should there arise a need for a still greater exposure, the flat abdominal muscles may be cut transversely. When the transverse colon or the splenic flexure require exposure, one had better resort to a second incision. This is made parallel to the left costal border, the underlying muscles being split in the same direction.

*Localization* The sigmoid is usually found close to the incision. It frequently prolapses into it. When it is not visible the small intestine is packed off to one side with the aid of a large laparotomy sponge. Elevation of the end of the table at this stage aids in exposing the operative field. The sigmoid is seized and is brought out of the peritoneal cavity. The tumor is readily delivered when it is located in the mobile portion of the sigmoid and when it is not bound down by adhesions or by a shrunken mesosigmoid. In favorable cases of this type, the peritoneal cavity is packed off and all further manipulations are carried out outside of the abdomen. When adhesions are present one must first expose them properly in order that one may decide by direct inspection as well as by palpation the feasibility of attacking them. The possible extension of the growth into the depth, the presence of metastases in the peritoneum of nodes in the mesentery, in the pouch of Douglas in the vicinity of the growth etc. Further consideration is to be given to the kind of adhesions. They may be of the type that are easily separated or on the other hand firmly bound to the abdominal wall or to an abdominal viscus or embedded in an indurated mass. The presence of just such indurated tumor-factions should suggest the possibility of an abscess in the vicinity of the new growth, or an abscess the result of sigmoiditis. The unexpected

unguarded breaking into one of these may result disastrously for the patient.

*Freeing of the growth* When we rule out the slender adhesions, such as result from a previous laparotomy made for an acute obstruction due to the tumor or from an inflammatory disease of the female adnexa, we must regard as serious complications all other adhesions of the new growth to the tissue about it and to the neighboring organs and every fixation caused by mesenteric involvement. This must be clearly kept in mind before the radical procedure is decided upon, for once begun there is no backing out. The bowel may be injured, and then the radical removal of the growth and of the tissue about it must be completed in the face of every difficulty and hazard without this an acute peritonitis is unavoidable. One must be prepared in these cases to remove a neighboring viscus such as the uterus the ovary or an adherent coil of the small intestine. Tumors involving the mesosigmoid as well as those fixed to the iliac region are dissected out by incising the posterolateral peritoneal wall and working from their lateral aspect in the median direction. In the course of this dissection, one should particularly remember the ureter. The iliac vessels may come into the operative field. They should be freely exposed so as to avoid injury to them.

*Choice of the method of resection* Upon the delivery of the tumor from the peritoneal cavity one is confronted with the question of a one stage or two stage method of procedure. A condition *sine qua non* for a one stage procedure is a thoroughly emptied bowel. When this condition does not obtain one had better resort to the two stage method. We shall next describe the one stage method.

*Ligation of mesosigmoid vessels* If the mesosigmoid is easily accessible then with the aid of an artery forceps a slit is made in it and sections 1.5 to 2 centimeters wide are grasped between two artery forceps to the right and to the left of the slit. These are cut between the clamps and the centrally directed portion is ligated. This is continued until the bowel to be resected is freed. When there is not sufficient room to work in, the cutting of the mesosigmoid may be made between a ligature on the one hand and the clamp on the other. Mesosigmoid ligature of course must be made central to the diseased part of the bowel as well as to the diseased lymph nodes. In difficult cases it is best to begin with the ligation of the biggest vessel. If there are enlarged lymph glands or much fat, the vessels must be carefully dissected and doubly ligated, and only if the vessels are plainly visible and easily approached, transfixed



Fig. 1

Fig. 2

Fig. 3



Fig. 4

Fig. 5

Fig. 6

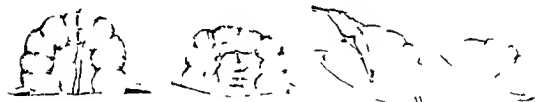


Fig. 7

Fig. 8

Fig. 9

Fig. 10

sutures may be applied. No preliminary ligations should be made in the immediate vicinity of the line of resection. Here close to the bowel the mesentery is freely incised and the bleeding vessels are separately clamped and ligated.

**Resection of the inflamed bowel.** This is done with the knife between two hard clamps. The line of incision is made oblique so that more is removed from the anti-mesenteric than from the mesenteric border. If the bowel is long enough additional soft clamps may be placed three to four finger breadths above and below the line of resection. The resection is of course preceded by a careful isolation of the segment to be resected and by a careful packing off of the abdominal cavity. Two extra towels are now laid on the dressings and are secured with skin clips or artery forceps. These protect the underlying isolating dressing

against soiling and are to be immediately replaced when soiled. Dissection is made with a knife between two closely applied clamps.

**Apposition of bowel stumps.** After inspection and change of outer dressings, surrounding the bowel stumps the clamps are removed first from the aboral then from the oral side. The assistant quickly grasps the mesenteric and the anti-mesenteric ends of the bowel stump with artery forceps and holds them up high. The compressed edges are now carefully separated, the adherent mucus is wiped away with small sponges. In the absence of an upper clamp a piece of gauze is placed in the lumen and the edges of the stump are fixed by two or three artery forceps. The two stumps are now laid side by side at the point of mesenteric attachment and two or three interrupted catgut sutures are passed through the

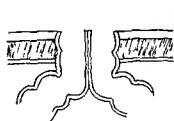


Fig 11

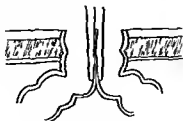


Fig 12

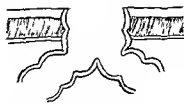


Fig 13

whole thickness of the intestinal wall at this point and tied within the lumen (Fig 1). Next, a catgut suture passing through the whole thickness of the intestinal wall is placed at the antimesenteric border and is tied on the inside and left long as a stay suture.

**Through and-through suture.** While the assistant holds up the antimesenteric stay suture a through and through catgut suture beginning at the mesenteric border is passed through the edges, the needle passing 2 or 3 millimeters away from the border thus bringing the stumps in apposition. When the suture has progressed to within 2 centimeters of the antimesenteric border another single catgut suture is passed through the whole thickness of the bowel on both sides and is tied from the inside. This now serves as a new stay suture. The continuous suture is taken up once more (Fig 4). Two centimeters further another interrupted suture is placed and then still another at the same interval and so on until two thirds of the bowel circumference has been sutured. At this stage the running suture is tied to the last interrupted and cut. An interrupted suture is now placed on the outside so as to bring the bowel edges to within 2 to 3 millimeters so that serous flaps will approximate each other to that extent. This suture is left long and is tied to the end of the circular through and through suture which has now begun on the other side at the mesenteric end (Fig 6). At this stage of the suture the bowel is sewed from the outside; the needle is made to pass through the serosa to reappear at mucous edge to pierce the mucosa of the opposite side and come out once more 2 to 3 millimeters on serous surface of opposite side. The soft clamps and gauze sponge within the lumen are removed when suture line is within 2 to 3 centimeters of completion.

**Serous suture.** The two large upper sponges are now removed even if not soiled. The suture line is wiped dry and the gloves and instruments are changed. The serous layers of the large intestines should always be sutured with interrupted sutures to make sure that each suture grasps a definite amount of tissue. The bowel serosa should prefer

ably be sutured to bowel serosa and epiploic appendages utilized only when bowel serosa is not to be had. These appendages must be grasped by the needle close to their base. The sutures are placed 3 to 4 millimeters apart. One begins 1.5 to 2 centimeters beyond the bowel border on one side of the mesentery and ends 1.5 to 2 centimeters above the mesenteric border of the other side. Contrary to the suggestion of some surgeons the epiploic appendages should not be removed. There is in the first place the danger of unwittingly opening into a Graser diverticulum, and on the other, these appendages may be utilized for the reinforcement of the suture line. They are secured to it by one or two serous stitches. For a serous suture I always use the finest silk and the small curved needle.

**Suture of the mesentery.** The breach next the bowel is closed as already mentioned with the serous suture 1.5 to 2 centimeters wide. The rest is sutured with catgut in such a way that the ligatures are covered with serosa.

**Making the suture line safe.** The sponges are now removed from the field of operation and from the peritoneal cavity. The peritoneal edges are grasped with forceps and the peritoneal cavity is examined for bleeding, sponges etc. The parietal peritoneum is stitched to the sigmoid anastomosis in such a way as to leave at least four finger breadths of the oral portion of the bowel outside of the peritoneal cavity (Fig 9). If possible the suture line of the mesentery is included as well, though this is not so important. Aboral from the anastomosis only about one finger breadth of the bowel is thus extraperitonealized. If a caecal fistula is present this width would do for the oral segment as well. The peritoneum is stitched with fine interrupted silk sutures, 3 to 4 millimeters apart in the immediate vicinity of the anastomosis elsewhere 1 to 1.5 centimeters apart. In the lower medial angle of the wound where the peritoneum was sutured to the bowel one finger breadth below the anastomosis the parietal peritoneum is grasped not at its edge but 2 to 2.5 finger breadths back of it, and is thus sutured to

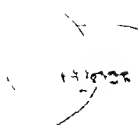


Fig. 14



Fig. 15



Fig. 16

the serosa of the sigmoid. This results in a free peritoneal flap some two finger breadths in width which is to be utilized later to protect the anastomotic line against the dressings (Fig. 16). One might utilize an epiploic appendage or a piece of omentum for the same purpose, although this is best accomplished by means of the peritoneal flap just described.

The segment which lies over (orally from) the anastomosis is now designated by passing two very fine silk sutures through its serosa and muscularis. These sutures are tied loosely and left long. They indicate the location where the bowel is to be opened when the case requires it. When a cecal fistula is present this precaution is not necessary nor is it necessary to extraperitonealize much of the oral segment.

**Dressing.** Three gauze drains are used ordinarily. One is placed over the anastomotic line protected by the peritoneal flap, by an epiploic appendage or by omentum. One is placed over the bowel over the anastomosis and one to the lateral side of the bowel. In cases in which much retroperitoneal dissection is done more packing is necessary.

**Suture of the abdominal wall.** The abdominal wall is sutured in layers, muscles and aponeurosis with catgut, skin with silk and metal clips sufficient room being left for the gauze drains.

**Bandage.** Gauze dressings are held in place by adhesive strips laid transversely across the abdomen. Cotton and a calico binder are placed over these, the latter being secured with safety pins.

#### MULTIPLE STAGE RESECTION

**First procedure—resection.** The preliminary steps—incision, ligation of mesosigmoid vessels—are the same as for the one stage operation. When however because of the presence of feces in the bowel the one stage method appears inadvisable one proceeds as follows:

The two limbs of the delivered sigmoid are placed parallel to one another in a flint barrel

fashion and are joined with a fine serous suture for such an extent as the case permits at least three finger breadths. Undue tension must be avoided in order not to run the risk of angulation perforation etc.

The parietal peritoneum is now sutured with fine serous sutures 1/2 centimeters apart to both limbs in a circular fashion so that the peritoneal cavity is completely shut off at the base of the delivered bowel.

Gauze dressings are placed above and below both limbs and the wider dressing to the side of the bowel.

The abdominal wall is sutured in layers, room being left for the gauze drains and the bowel.

On completion of the skin suture the wound is covered with large dressings and the bowel is tied off with heavy silk on either side at the level at which it is to be amputated. Next, the bowel is compressed with a powerful clamp 2 to 3 centimeters above the silk ligature and is severed between the ligature and the clamp. This is best accomplished with a thermocautery.

**Bandage.** Same as in the one stage operation.

**Second act—crushing of the spur.** This is done 2 to 3 weeks later. By this time the bowel empties itself normally through the proximal stump and the incision is to a great extent healed. Small defects in the wound corresponding to gauze drains are of no consequence. The patient is thoroughly purged a day or two before the operation and the aboral stump is thoroughly washed out by an enema or by a catheter introduced through the proximal opening of the aboral stump. The extent and the width of the partition between the two limbs is ascertained by passing the index finger into each lumen. The straight forceps is now introduced under the guidance of the finger one blade into each lumen so that when the two are closed the partition is grasped between them. Instead of one wide forceps one can use two small ones placed close to each other. This forceps is closed with considerable force. In a day or

two the partition dividing the two limbs necrotizes and the forceps are removed (Figs 11 to 13). About a week later the communication between the lumina of the two limbs is explored with the finger. If it is deemed insufficient, a forceps is placed on the remaining spur in the same manner as before.

*Third stage—closure of the fistula.* One must wait for the complete healing of the incision and for the complete union between the bowel mucosa and the skin. When the mucosa prolapses the operation is much easier. The patient is once more purged a day before the operation and the segment of the bowel between the fistula and the anus is irrigated. This operation can easily be performed under local anesthesia (infiltration with a one per cent novocain solution).

An incision is made in the scar between the skin and the mucosa. The edges of the latter are seized with fine artery forceps, are pulled away from the skin and are dissected from it by scalpel. The bowel is freed all around and is then closed by a number of interrupted sutures of fine catgut if possible, in a direction transverse to the long axis of the bowel (Fig. 14). On completion of suturing the wound is wiped with a well diluted solution of tincture of iodine and a change of gloves, instruments and dressings is made. The cutaneous scar is now excised. When the latter is thin it is sufficient to remove a width of 0.5 to 1 centimeter. The sutured bowel is dissected free from the subcutaneous fat and aponeurosis and the first suture line is buried by means of a few serous sutures of fine silk (Fig. 15).

The skin and the aponeurosis may be mobilized if necessary and closure is accomplished by means of two U shaped mattress sutures of stout silk worm gut. This is the most important step in this stage of the operation. A suture on a large curved needle is made to pass say from the right side of the wound 1.5 to 2 centimeters from its edge through the skin. It is made to appear above the aponeurosis to cross over to the opposite side then goes below that (left) side of the aponeurosis and around the (left) side of the bowel comes out under the (left) edge of the aponeurosis wound and returns to the opposite side passing above the aponeurosis through the subcutaneous fat and skin and emerges again 0.5 to 2 centimeters from the skin wound (right) edge. The same procedure is repeated from the opposite side the needle being passed through the skin and subcutaneous fat of one side, then below the aponeurosis and around the side of the bowel of the opposite side to be returned through the subcutaneous fat and skin of the original side. Each suture is tied over a roll

[Y]

[Y]

Fig. 17

of gauze (Fig. 17). This procedure results in bringing wide segments of soft tissue over the repaired bowel. No further suture of the skin is necessary as a rule. Eventually one or two superficial silk sutures may be added. A small gauze drain is inserted into each angle.

#### POSTOPERATIVE TREATMENT

*After the one stage operation.* The patient is put to bed in a half sitting posture. No food is given the first day. On the second and third days tea, water lemonade, and fruit juices are given. On the fourth and fifth days bouillon and thin soups are added. When flatus has been passed milk, sour milk, coffee, and thicker soups may be given. From the sixth day apple sauce, paps of potatoes, of green vegetables and gruel are added, meat being given only after the first copious bowel movement. No opiates or enemas are administered. After the second day a thick rectal tube is frequently passed. If the flatus is not passed before the third or fourth day, small enemas of oil and glycerin diluted in water not to exceed 50 cubic centimeters are administered. After the fifth or sixth day, when flatus has been passed spontaneously, cathartics, preferably castor oil, may be given by mouth.

*Change of dressings.* On the day following the operation the outer dressings are changed, after that every day or every other day. The gauze drains are moistened lightly with hydrogen peroxide and are not changed until the eighth day. In the presence of a profuse secretion, however, this may be done a day or two earlier. If fecal matter appears in the wound the dressings must be changed daily and oftener. The wound is liberally irrigated with hydrogen peroxide and the skin is protected with a thick layer of zinc paste or veroform salve. In most cases there is very little fecal discharge in the dressings and that soon disappears. Extensive separation of the suture line followed by profuse discharge of feces is not frequent and even these heal in the course of a few weeks.



*The after treatment after the first act of the two stage operation is the same as that described for the one stage operation*

Faeces appear in the incision on the third or fourth day. The ligature on the bowel will cut through spontaneously. However if the patient complains of distention, the ligature may be removed from the proximal stump as early as the day after the operation. The dressings may have to be changed several times in the course of the day. The skin is protected with a heavy layer of xeroform or zinc silve. The gauze drains are changed on the eighth day. Baths are given after the second week.

The treatment after the *second act* does not differ from the preceding one. After the *third act* the dressings are changed on the day following the operation thence once every 2 days. The drains are removed on the eighth day the superficial skin stitches at the same time. The deep mattress sutures are left in for 10 to 12 days as long as they are not cutting through. A slight faecal discharge may appear in the incision. If the wound is not infected and the patient is afebrile nothing is done. Should an abscess eventually form it is treated by timely spreading of the wound. As a rule the healing progresses

smoothly. An occasional faecal fistula closes spontaneously.

Stress must be laid upon the diet during the first week after the repair of the fistula. This should consist so far as possible of tea, lemonade, orangeade, and thin soups. The bowel is relieved by rectal tube and small enemas. Copious enemata are to be avoided. Laxatives by mouth are given on the sixth or seventh day. A more solid diet is given only after a bowel movement has been obtained.

#### COMPLICATIONS

Among these are collection of secretions under the drains and abscess formation in the incision. These are treated by removal of superficial and deep stitches and by separation of the wound edges. Phlegmons are treated by incision. The danger of peritonitis may be said to be almost positively excluded by the use of the method of extraperitonealization of the suture line in both operations. This is true however only if meticulous care is exercised at the time the tumor is delivered that proper protection be given to the peritoneum in the course of suturing that gloves and instruments are changed often and all tension is avoided. The danger of pneumonia is less than after gastric operations.

FROM THE CLINIC OF THE WOMAN'S HOSPITAL, NEW YORK

## THE "WARREN APRON" IN REPAIR OF HIGH LACERATION OF THE RECTUM ASSOCIATED WITH THIRD DEGREE LACERATION OF THE PELVIC FLOOR

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In 1882 Dr. J. Collins Warren presented before the American Gynecological Society a contribution entitled "A New Method of Operation for the Relief of Rupture of the Perineum through the Sphincter and Rectum." The operation has been used extensively and endorsed by surgeons for the third degree lacerations of the pelvic floor but is considered not to be applicable when the laceration extends high in the rectum. If however the dissection of the flap is begun high on the posterior wall of the vagina just below the cervix and is extended out side and below the sphincter and puts on either side the apron or flap will be sufficiently long to extend below the tear in the rectum and thus protect the wound which now lies anterior to the flap.

The technique of the operation to be described differs from the Warren operation chiefly in the outline of the flap to be used and the modern method of repairing injuries to the pelvic floor by suturing the torn urogenital diaphragm and reuniting the separated levator muscles. This method of repair has been used by the writer in 12 patients, 10 of whom have had an absolutely perfect result. Two cases required additional suturing owing to excessive catharsis in one case

and a too wide separation of the legs when placed in the holding stirrups in another. In neither patient was there any injury to the flap and both had a satisfactory result. The operation is best done after a full 6 months' interval has elapsed from the last confinement, as this allows ample time for the tissues in the pelvic floor to undergo involution. The most favorable time in the month is 2 or 3 days after the cessation of the menstrual flow so that there will be time for healing before the next period begins. The bowels should be moved thoroughly the week of the operation preferably with castor oil (1 ounce) given 4 and 2 days before the operation, and a high enema the day of the operation—6 to 8 hours before the time set for the repair. A limited diet with little residue should be given on the 3 days previous to the day of the operation.

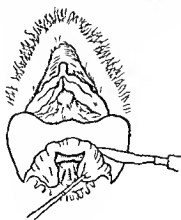


FIG. 1. Outline of apron (After J. Collins Warren)

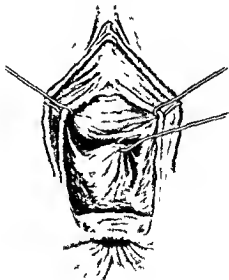


FIG. 2. Outline of operation field (After Howard A. Kelly)

*The after treatment after the first act of the two stage operation is the same as that described for the one stage operation*

Faeces appear in the incision on the third or fourth day. The ligature on the bowel will cut through spontaneously. However, if the patient complains of distention the ligature may be removed from the proximal stump as early as the day after the operation. The dressings may have to be changed several times in the course of the day. The skin is protected with a heavy layer of zoroform or zinc salve. The gauze drains are changed on the eighth day. Baths are given after the second week.

The treatment after the second act does not differ from the preceding one. After the third act the dressings are changed on the day following the operation thence once every 2 days. The drains are removed on the eighth day. The superficial skin stitches at the same time. The deep mattress sutures are left in for 10 to 12 days as long as they are not cutting through. A slight faecal discharge may appear in the incision. If the wound is not infected and the patient is afebrile nothing is done. Should an abscess eventually form it is treated by timely spreading of the wound. As a rule the healing progresses

smoothly. An occasional faecal fistula closes spontaneously.

Stress must be laid upon the diet during the first week after the repair of the fistula. This should consist so far as possible of tea, lemonade, orangeade, and thin soups. The bowel is relieved by rectal tube and small enemas. Copious emata are to be avoided. Laxatives by mouth are given on the sixth or seventh day. A more solid diet is given only after a bowel movement has been obtained.

#### COMPLICATIONS

Among these are collection of secretions under the drains and abscess formation in the incision. These are treated by removal of superficial and deep stitches and by separation of the wound edges. Phlegmons are treated by incision. The danger of peritonitis may be said to be almost positively excluded by the use of the method of extraperitonealization of the suture line in both operations. This is true however only if meticulous care is exercised at the time the tumor is delivered that proper protection be given to the peritoneum in the course of suturing that gloves and instruments are changed often and all tension is avoided. The danger of pneumonia is less than after gastric operations.

FROM THE CLINIC OF THE WOMAN'S HOSPITAL, NEW YORK

## THE "WARREN APRON" IN REPAIR OF HIGH LACERATION OF THE RECTUM ASSOCIATED WITH THIRD DEGREE LACERATION OF THE PELVIC FLOOR

LILIAN K. FARRAR, A.B., M.D., F.A.C.S., NEW YORK

IN 1882 Dr. J. Collins Warren presented before the American Gynecological Society a contribution entitled "A New Method of Operation for the Relief of Rupture of the Perineum through the Sphincter and Rectum." The operation has been used extensively and endorsed by surgeons for the third degree lacerations of the pelvic floor but is considered not to be applicable when the laceration extends high in the rectum. If however the dissection of the flap is begun high on the posterior wall of the vagina just below the cervix and is extended out side and below the sphincter and pits on either side the apron or flap will be sufficiently long to extend below the tear in the rectum and thus protect the wound which now lies anterior to the flap.

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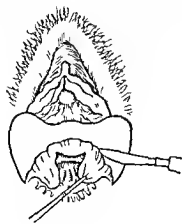


Fig. 1 Outline of apron (After J. Collins Warren)

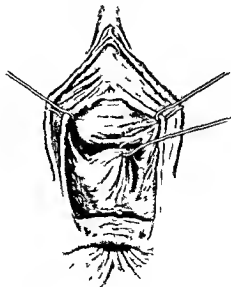


Fig. 2 Outline of operation field (After Howard A. Kelly)

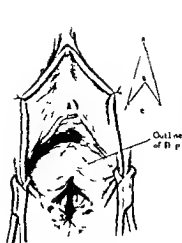


Fig. 3

Fig. 3. Outline of apron. 1. Dissection begun just below cervix *B* upper end of tear in rectum. *C* point on imaginary line between ends of sphincter ani muscles.

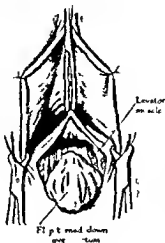


Fig. 4

Fig. 4. The flap has been turned down over the tear in the rectum.

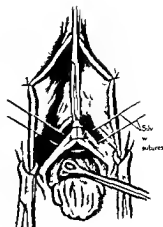


Fig. 5

Fig. 5. Silver wire sutures placed anterior to flap.

Before outlining the flap, the sphincter ani muscles are thoroughly stretched and a 12 inch strip of 1 inch wide iodoform gauze is packed lightly into the rectum. The technique of the operation is well shown in illustrations. Figures 1 and 2 show the Warren and Kelly flaps. Figure 3 is an outline of the apron which we use. The dissection is begun just below the cervix *A* to *B* must equal or be a little longer than *B* to *C*. The incision must extend outside of the sphincter ani pits and a little below them. Dissect free a thick flap in the area outlined up to the lines extending from just below the sphincter ani pit on one

side to the point *B* and down to a point just below the sphincter ani pit on the other side, keeping a finger back of the flap as a guide when approaching the edge of the rectum. The flap will now hang down over the tear in the rectum and *A* will cover point *C* (Fig. 4). Carry 3 to 5 silver wire sutures anterior to the flap in the vaginal portion of the operating field (Fig. 5). The first suture should be above the apex *A*, to take the strain off the rectum when it is re- united. The second wire suture should be introduced into the mucous membrane on the left side about  $\frac{3}{8}$  inch from the margin of the denuded area and deeply enough to pick up the edge of the torn urogenital diaphragm. It should come out at the margin of the flap and catch up lightly tissue in the flap to prevent a dead space as first advised by Tait and should be re-introduced at the right margin of the flap taking the torn edge of the diaphragm on the right and out on the mucous membrane. Successive sutures should be passed in exactly the same way until the mucocutaneous junction is reached. The anterior fibers of the levator ani muscles are then found.

The levator muscles are sutured with No. 2 catgut and 2 to 3 silver wire sutures are passed from the skin surface of the perineum under the levator muscles (Fig. 6).

When the levator muscles are united they act as a guide to the torn sphincter muscle which should be sutured with No. 1 tanned gut after they have been dissected out. Two wire sutures

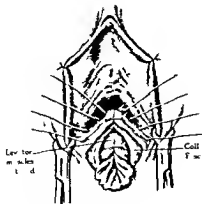


Fig. 6. Levator muscles sutured with No. 2 catgut.

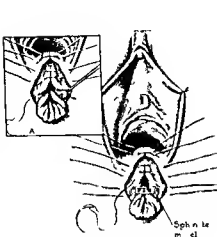


Fig. 7

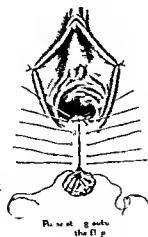


Fig. 8

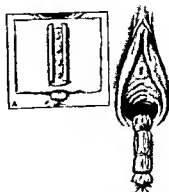


Fig. 9

Fig. 7 Torn sphincter is sutured with No. 1 tanned gut  
Fig. 8 Purse string suture closes edges of flap which may be attached to or spread out to fit the edge of the anus

Fig. 9 All wire sutures are twisted and those in the vagina have their ends covered with a washer and shot firmly crushed

are then passed deeply under the torn edges of the sphincter muscle. The upper edge of the sutured sphincter muscle may be sutured to the levator muscle where Luschka's fibers normally are. A continuous No. 2 tanned gut suture closes Colles' fascia and is tied later to the end of a No. 1 tanned gut suture passed subcutaneously in the skin margins beginning at the mucocutaneous junction and ending at the anal margin (Fig. 7).

The flap now hangs in the restored anus and a purse string suture will close the edges which may be attached to or spread out to fit the edge of the anus. This flap will contract and be withdrawn into the rectum where it can be felt weeks later only as a slight thickening on the anterior wall of the rectum (Fig. 8).

All wire sutures are now twisted and each one in the vagina has its ends covered with a washer and a shot firmly crushed. The twisted wire sutures on the skin surface are passed through a piece of perforated rubber tubing covered with thin rubber. The ends of the wires are covered with shot and the outer rubber covering is tied over the tube to keep it water tight as in the technique which is employed by Dr. Herman Grad of the Woman's Hospital. The gauze is removed from the rectum and the knees are kept tied until the patient becomes conscious (Fig. 9).

#### AFTER CARE

The perineum must be kept clean by pitcher douches of potassium permanganate solution

after each urination or bowel movement. The diet should be liquids chiefly—no milk should be given, however.

The bowels are moved on the fifth day by Epsom salts repeated if necessary. Enemas are never given.

The silver wire sutures are removed on the fourteenth day under gas oxygen anaesthesia, care being taken not to stretch the pelvic floor by placing the legs in stirrups.

The principles of the repair of the pelvic floor have been taught by Emmet Tait, Marcy, Watkins and Ward, the anatomy demonstrated by Edouard Martin Testut and Jacob, Halban and Tandler and others the method of repair of third degree laceration of the pelvic floor by Kelly, Watkins, Ristine and Noble. So completely has this been done that one can only assemble the technique to fit each individual case keeping always in mind the importance of uniting the edges of the torn urogenital diaphragm and suturing together the levator muscles after reaching the mucocutaneous line where they normally decussate with one another before the injury. The support of the pelvic floor depends not on muscle or fascia alone but upon the integrity of both muscle and fascia working together.

My appreciation and grateful acknowledgment are due to Dr. Howard A. Kelly for his invaluable guidance of many years and in this instance for his teaching the repair of the complete laceration of the sphincter ani muscle.

## BIBLIOGRAPHY

- 1 CARPPELL J F Perineal injuries during parturition with report of 336 cases. *Am J Obst & Gynec* 1927 **xiii** 627-632
- 2 CUNNINGHAM Anatomy 1926
- 3 DELTCHMAN D A plea for the preservation of the perineum and a modified prophylactic episiotomy for the prevention of perineal lacerations. *Med J & Rec* 1924 **cxx** 150-153
- 4 EMMET THOMAS ADAMS Laceration of the perineum involving the sphincter ani and the operation for securing union of the muscle. *Med Rec* 1883 **xviii** 121
- 5 FARRAR LILIAN K P Fascia and ligaments of the pelvic floor. *Kelly's Gynecology* 1928
- 6 HALBAN JOSEF Operative Behandlung weiblicher Genitalprolapse und der Berücksichtigung der Anatomie und Ätiologie. Vienna 1919
- 7 HALBAN and TANDLER Anatomie und Ätiologie der Genitalprolapse beim Weibe. Vienna 1907
- 8 KELLY HOWARD A Lacerations of the perineum. *Kelly's Gynecology* 1928 pp 283-287
- 9 LEFÈVRE F Considerations sur la résection immédiate du périnée déchiré par l'accouchement. *Ann de l'In t chir de Brux* 1922 pp 152-155. *Arch méd belges* **lvi** 983-986. *Rev franç ginec et obst* 1922 **xviii** 430
- 10 MARCY H O The reconstruction of the pelvic structures in woman. *Am J Obst* 1892 **xviii** 68
- 11 MARTIN EDOLARD Der Haftapparat der weiblichen Genitalien. Berlin 1911
- 12 NOBLE GEORGE H An operation for complete laceration of the perineum designed for the purpose of eliminating danger of infection from the rectum. *Tr Am Gynec Soc* 1902 **xviii**
- 13 ORR J L Primary repair modified technique and after treatment. *Glasgow M J* 1928 **cix** 314-319
- 14 RINTINE A new method of operation for complete tear of the perineum. *Am J Obst* 1900 **xii** 303
- 15 SISTERMAN W E Plastic surgery open operation for extensive laceration of anal sphincter. *Ann Surg* 1927 **lxxviii** 187-190
- 16 TAIT LAWSON Diseases of Women and Abdominal Surgery 1889
- 17 TESTUT and JACOB Traité d'Anatomie Topographique 1914
- 18 TITUS PAUL Surgery episiotomy and immediate postpartum repair of both old and new perineal injuries. *Am J Surg* 1921 **iii** 490-503
- 19 WARD GEORGE GRAY JR The problem of the rectocele. *Surg Gynec & Obst* 1913 **xvii** 361. Rectocele Enterocoele Injury to the Pelvic Floor. *Kelly's Gynecology* 1928 Chapt xx
- 20 WARREN J COLLINS A new method of operation for the rebel of rupture of the perineum through the sphincter and rectum. *Boston M & S J* 1878 **xviii** 25. *Tr Am Gynec Soc* 1882 p 322
- 21 WATKINS THOMAS J Perineorrhaphy for complete laceration. *Surg Gynec & Obst* 1911 **xxii** 360

CHRONIC DUODENAL ULCER<sup>1</sup>

JOHN B. DEAVER, M.D., F.A.C.S., PHILADELPHIA

**D**UODENAL ulcer is an ever absorbing subject of contention among the profession. Some maintain that especially in its early stages it is a medical condition and should be so treated, others urge more radical i.e. surgical treatment. Some claim that even a positive X-ray report does not always establish the diagnosis; others base their diagnosis on the roentgenogram and on the results of laboratory tests. Some contend the symptoms are simulated by duodenitis and inflammation of a duodenal diverticulum; others stress the differentiation between ulcer and disease of the gall bladder and the appendix. Even among those who advocate early surgery there are differences of opinion as to the proper surgical procedure. As a matter of fact each and every one of these opinions is justified and it is practically impossible to describe a definite picture or prescribe a definite course of treatment that will apply to every case. Duodenal ulcer in short refuses to conform to the modern trend of standardization because the human subject itself cannot be completely standardized.

This tendency to resist standardization depends on various factors. One of these is the site of the ulcer. The typical duodenal ulcer is found in the upper 3 centimeters of the anterior wall of the duodenum and in many cases the per ulcerous exudate extends up to or within a short distance of the pylorus. The deepest part of the ulcer will usually be found just below the pylorus where the acid secretion which is ejected with considerable force from the stomach produces an impact upon the duodenal mucosa at this point. Ulcer is rarely met with below the papilla of Vater where the acid chyme is neutralized. Physiologically the consensus of opinion seems to be that the acid in the pyloric end of the stomach stimulates the gastric and secretory functions. In the upper duodenum it controls pyloric function and the rate of the gastric excretion is regulated by the rapidity with which this acid is neutralized by the alkaline biliary and pancreatic secretions. According to some authorities pathologically the acid gastric juices either because of perverted secretion, or through lack of local resistance, or both become the most important factor in the development of ulcer and largely confine their ravages to the duodenum.

The ulcer is usually round and varies in diameter from 1.5 to 3 centimeters or more. The base

is either the submucosa, the head of the pancreas, or the thickened connective tissue (Fig. 1).

Inspection shows stippling or a white central exudate with radiating white lines which can be likened to a wheel, the central white point representing the hub and the radiating white lines the spokes of the wheel. Not all ulcers however give so distinct a picture. Ulcer of the anterior wall of the duodenum, the most common site, cannot always be recognized even when the duodenum is exposed and drawn upward and partly out of the wound by traction upon the pyloric end of the stomach because it is often covered over by or grized exudate in the shape of a peritoneal sheet which may be styled pathological peritoneum, the surface of which frequently is greasy and dirty looking (Fig. 2). This may be one reason for overlooking an ulcer unless the surgeon adds careful dissection and palpation to inspection. When operating before an audience of students I cleanse the surface of the duodenum by carefully dissecting off the covering referred to so as definitely to demonstrate the ulcer (Fig. 3).

When the ulcer is on the posterior wall of the duodenum its recognition is even more difficult. Here likewise we must look well and palpate well otherwise the ulcer will be missed. The recognition of exudate in the lower portion of the free border of the gastro-hepatic (Fig. 4), lesser omentum in juxtaposition to the duodenum is a sign post that points to the site of the ulcer which with the detection of the crater (which can be done by contacting the anterior bowel wall with the ulcer) justifies opening the duodenum. Then as the margins of the incised walls of the duodenal wound are retracted, the ulcer will be exposed (Fig. 5). I place great value on the use of the Cameron light in these cases. In fact by this means I am able to demonstrate the ulcer to the visitors in my clinic. Furthermore by this technique if there is more than one ulcer present, it can be detected.

While writing this discussion I was much pleased to read of Balfour's ingenious method of determining the presence of ulcer of the posterior wall of the duodenum by incising the stomach close to the pylorus and introducing the finger into the duodenum to detect the ulcer and immediately closing the opening. This simplifies the detection of the ulcer. Incidentally I may say I have also done this to determine the patulousness of the



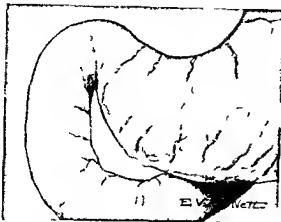


Fig 1 Ulcer of duodenum Stippling of surface



Fig 2 Pathological band of peritoneum covers ulcer

pylorus where I have been in doubt as to its size after making a plastic operation upon it

W J Mayo has called attention to the appearance of an anæmic spot on the duodenum which may be mistaken for ulcer. The arrangement of the blood vessels of the duodenum just below the pylorus is such that if the pyloric end of the stomach is pulled forward rather firmly as must often be done to obtain a view of the parts this anæmic spot will appear in the duodenum just below the pyloric ring. This is very striking and may closely resemble an ulcer. The tissues apparently involved are normal to the touch and do not have the mulky appearance of the peritoneal covering of a true ulcer and stippling, an open area of organized exudate with white lines radiating therefrom adhesions and other abnormalities are absent. When the traction is relieved it will be seen at once that no ulcer exists. The underestimation of surgery of the stomach and duodenum and some of the unsatisfactory results reported are without doubt largely due to mistaken diagnoses and unnecessary operations for supposed but non existing ulcer.

Duodenal ulcer is usually single although occasionally there may be a second ulcer so that examination for more than one ulcer is important (Fig 6). When the ulcer is demonstrated the duodenal cap usually is easily shown since it is not apt to be surrounded by adhesions. Periduodenal adhesions due to ulcer are not nearly so frequent as are pericholecystic adhesions the result of a diseased gall bladder. On the other hand, the duodenal deformity as shown by the roentgenogram and caused by pericholecystic adhesions a duodenitis or an inflamed diverticulum may simulate ulcer findings, so that the X ray report

is not always conclusive except that it shows pathology, which after all is the most important finding.

There are no known constitutional peculiarities which predispose to duodenal ulcer. The etiology I believe is infection from a more or less distant focus although the many theories offered to explain its origin show that many other factors may play a part in its pathogenesis and that these factors probably differ in different cases.

Duodenal ulcer occurs most frequently in the male sex the reason for this preponderance is not clear. Mayo explains it on the basis of mechanics the first or ascending portion of the duodenum in the average male ascends somewhat higher than in the average female and as a result the alkaline secretions may rise higher and thus more readily neutralize the acid secretion in the first portion of the duodenum in women than in men.

The diagnosis of typical duodenal ulcer does not present great difficulty because the symptoms usually appear in a well defined sequence so well defined in fact that in most instances we need not hesitate to make the diagnosis from the clinical history and feel confident of having it confirmed at operation.

The typical case history of duodenal ulcer reveals years if not a lifetime of attacks of epigastric discomfort after meals that is a sense of fullness often described as a blown out feeling and a gnawing burning sensation rather than pain with acid eructations coming on from 2 to 4 hours after meals. This distress rarely appears after breakfast but with constant regularity after the heavier meals the so called hunger pain at night (about 2 a m) is one of the distinguishing features of the complaint. The reason for this

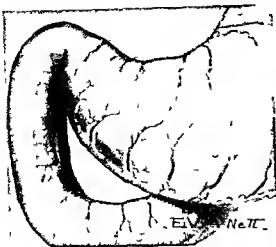


Fig. 3 Ulcer of duodenum

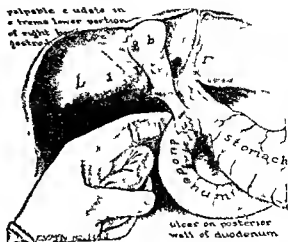


Fig. 4 Palpable exudate in extreme lower portion of right border of gastrophrenic omentum

hunger pain has not yet been satisfactorily explained. Moynihan attributes it to changes in the muscular activity of the stomach and the duodenum stimulated by changes in the chemical quality of the chyme, especially toward the end of digestion. Food relief or subsidence of pain after eating or taking an alkali (soda) is another characteristic feature. The rhythm of duodenal ulcer then, is food comfort, pain, and again food, comfort, pain. Mayo believes that in the greater number of cases the pain is caused by the irritant action of the acid acrid contents on the ulcer area of the duodenum itself, heightened by the accompanying pylorospasm and gas formation, while in the remaining cases it is due to a perforating peritonitis, a complication more frequent in duodenal than in gastric ulcer, because of the thinner walls of the duodenum. The field of radiation of the pain is usually limited to the gastric and the duodenal areas.

The periodicity of these attacks with intervals of complete well being is emphasized by all authorities. The attacks usually begin in early adult life. The patient complains of stomach trouble of which hyperacidity is a prominent feature. This appears in about 50 per cent of the cases. The symptoms recur with increasing frequency as the patient grows older. In the later stages mechanical obstruction of the pylorus occurs.

The physical signs in duodenal ulcer are practically nil, however, in long standing cases with much organized per ulcerous exudate, tenderness to deep pressure high up over the rectus muscle may be elicited. Hemorrhage from the bowel or by mouth, as evidenced by tarry stools or the pres-

ence of blood in the vomitus is noted in about one third of the cases. Some patients also show a low hæmoglobin percentage. Vomiting is not considered one of the commoner symptoms of ulcer of the duodenum, but it does occur in a few cases.

The motility of the stomach is an important finding. That the motility is abnormally rapid is shown by the fact that in a good percentage of cases nothing of the test meal or the full meal is recovered in the usual time when the stomach is siphoned after the administration of the meal. This hypermotility is also demonstrated by the X ray and the barium meal; they are thus of confirmatory rather than contributory value in the diagnosis.

Briefly stated, then we may say that epigastric distress 3 or 4 hours after meals, relieved by eating or by alkalis, high acidity, hyperactivity of the stomach and, in some cases, vomiting and hæmorrhage, are indicative of duodenal ulcer, that is, of the typical case.

It is, of course, the atypical ulcer that presents diagnostic difficulties. It more often simulates appendicitis especially if the appendix is high than other conditions from which it can more or less easily be differentiated, such as gastric ulcer, cholelithiasis, cholecystitis and chronic pancreatitis.

Chronic appendicitis frequently presents the same hunger pain as duodenal ulcer, while hyperacidity is not unusual and many cases show the same chronicity as exists in duodenal ulcer. The chief difference between the two is the freedom from discomfort in the duodenal ulcer between the attacks, while in appendicitis flatulency, gen-

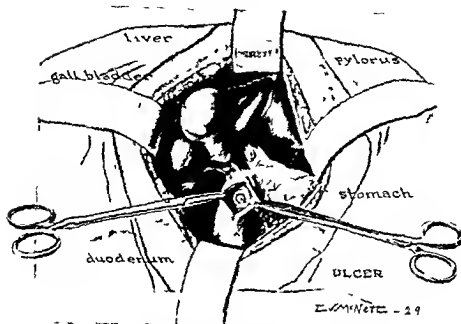


FIG. 3. Incision in anterior wall of duodenum to show ulcer on posterior wall

eral abdominal discomfort and lower abdominal discomfort and sometimes pain are apt to be constantly present. But the patients with appendiceal indigestion usually suffer more pain after certain kinds of food especially starchy food and red meats. The pain however is usually not so severe as in duodenal ulcer and the fact that it radiates downward is one of the principal points in the differential diagnosis. In appendicitis exercise frequently increases the local discomfort which is not true of duodenal ulcer. In fact the appendix is found diseased in so many cases of duodenal as well as of gastric ulcer that these peptic ulcers may be considered secondary conditions that is to say the result of infection from some other organ with the evidence strongly in favor of the appendix as the *corpus delicti*.

In distinguishing between gastric and duodenal ulcer we may to some extent be guided by the time relation of the ingestion of food and the onset of the symptoms. If pain appears soon after eating in one half to two hours and the food relief is not prompt, we may expect to find a gastric rather than a duodenal ulcer. Again the radiation of pain if any in duodenal ulcer are usually to the right while in gastric ulcer they are generally to the left. The pain is also apt to be more constant than in duodenal ulcer. The rhythm of gastric ulcer is food comfort pain comfort vomiting and hemorrhage usually in the form of

hematemesis are more frequent in gastric ulcer while in duodenal ulcer melæna is more frequent. Seasonal variations are less common in gastric than in duodenal ulcer. The diagnosis of gastric ulcer is a most uncertain one in fact it can be definitely made only by X ray examination or exposure at the operating table. Frequently the diagnosis of gastric ulcer is a myth and is not verified at operation.

The differential diagnosis of duodenal ulcer and cholelithiasis presents more difficulty but care in taking the history will usually enable the experienced clinician to forecast the true state of affairs. The diagnosis is oftentimes uncertain when adhesions exist between the gall bladder and the stomach and duodenum or when gall stones have been pushed toward the duodenum and since hyperacidity is also a symptom of gall stone disease it adds to the confusion. On the whole however cholelithiasis is marked by such severe colic like pain with sudden and unaccountable onset and almost as sudden and mysterious cessation that recognition as a rule should be easy. Lavage will frequently cut short an attack of biliary colic but will have no influence on the pain of a duodenal ulcer.

Pain in cholecystitis is sudden and usually severe with a wide field of radiation and comes with no regularity as to time. It is rarely caused by food however food by increasing gastric

peristalsis when there are adhesions, particularly to the gall bladder, will cause pain

The chronic gall stone case with impacted stone, ulceration and adhesions, and the absence of jaundice, in which gastric symptoms such as gas, vomiting, burning, distress, sour eructation, and impaired appetite predominate and pain is moderate and follows the taking of food, is too often mistakenly diagnosed ulcer, while duodenal ulcer if there is an early history of irregular attacks of sudden, sharp, intense pain, peritonitis or acute spasm, the absence of obstruction or hyperacidity and the presence of gas, vomiting or sour eructation is usually mistaken for gall stone

Symptoms similar to those of chronic pancreatitis or some pancreatic involvement such as peripancreatic lymphangitis, are not rarely met with in duodenal ulcer. This is not surprising in view of the close relationship existing between the duodenum and the pancreas and the frequent infiltration of ulcer into the pancreas itself as well as the close intercommunication between the pancreatic and duodenal lymphatics. For example, loss of weight and strength, pain in the back, a fairly constant clinical feature of chronic pancreatitis is recorded in a number of cases of ulcer. The character of the pain in chronic pancreatitis is moderate as it is in the majority of duodenal ulcer cases and there is the same epigastric oppression. A valuable distinguishing feature of pancreatic disease, however is that the pain has no definite relation to eating or drinking or the kind of food taken.

Duodenitis is by many regarded as a very early stage of ulcer and is not easily differentiated from actual ulcer. According to Judd it is the only lesion found in a surprisingly large number of cases giving a long and typical history and positive roentgenogram. Inflammation of a duodenal diverticulum likewise presents a syndrome scarcely distinguishable from ulcer although X ray study should demonstrate the presence of a diverticulum.

Malignant neoplasms of the intestines in their early stages sometimes simulate the symptoms of duodenal ulcer but careful inquiry will usually elicit the fact that the attacks of pain though presenting the same periodicity as in duodenal ulcer bear no relation to food neither in their onset nor in the relief of symptoms. In the atypical ulcer however nothing short of X ray examination or incision and inspection will enable us definitely to determine the nature of the lesion.

Unlike gastric ulcer duodenal ulcer rarely undergoes carcinomatous degeneration. Perforation is comparatively common in duodenal ulcer but fortunately the contents of the duodenum are



Fig 6 Duodenal ulcer just beyond pylorus

relatively sterile and small in amount, thus favoring plastic protection. W J Mayo calls attention to the fact that acute perforation of the duodenum is sometimes diagnosed perforative appendicitis and that a careful examination of the appendix in some cases of septic peritonitis from supposed appendiceal perforation would show that its peritoneal surface only is involved and that the lesion is in the duodenum. I have seen cases having all the earmarks of a perforative peptic ulcer, the sudden onset of most atrocious abdominal pain appearing like lightning out of a clear sky and in a short time followed by general board like rigidity of the abdominal wall and upon opening the abdomen high up I have been surprised to find the appendix perforated at or near the base. Again in cases of perforated ulcer that were not seen until several hours after the occurrence of the perforation, so that the spilled visceral contents had gravitated to the right lower abdomen by way of the external paracolic groove I have operated, believing the condition to be due to appendicitis, to find a perforated ulcer.

Hæmorrhage in duodenal ulcer is usually recognized from the appearance of the patient and the history, however this does not always apply, especially when the history is not typical. Confusion may arise in the differential diagnosis between hæmorrhage in duodenal ulcer, early Banti's disease and an ulcerative œsophageal varix. It is difficult in fact impossible to estimate the frequency of hæmorrhage in duodenal ulcer because of the causes of bleeding to which I will refer. It is certainly true that only a small proportion of the bleeding cases come under the surgeon's notice. When in doubt the patient's condition being good it is my practice to open the abdomen to settle the question at the same time if the lesion can be corrected mechanically. I of course do so. There is a difference of opinion whether the

patient should be operated upon immediately or allowed to recover from the effects of the hæmorrhage. This will have to be decided in the individual case; however, it has been my recent practice to operate in cases in which the red blood count is not below 3 500 000, the hæmoglobin correspondingly good, and the diagnosis as nearly certain as can be. Following this course I have had good results and see no reason for not continuing this practice, but it goes without saying with a display of good judgment. In my experience the operative mortality of a bleeding duodenal ulcer is very low, and if surgical measures were always resorted to sufficiently early the general mortality would be still lower. In the case of hæmorrhage from a gastric ulcer, however, we are dealing with a different proposition as the condition is more serious and the surgery more extensive.

Obstruction of the pylorus is not an uncommon condition in the old ulcer patient. It was formerly believed to be due to a gastric ulcer but since operations for duodenal ulcer have become increasingly frequent, it has been shown to be due to the peri-ulcerous erudate of the latter. Pyloric obstruction is readily diagnosed by means of the X-ray but a very simple test is to give an evening meal of raisins and wash out the stomach in the early morning before breakfast, when if raisin skins are recovered obstruction is self-evident. Giving a full meal and washing out the stomach several hours later will also show obstruction if the meal is recovered.

Although it is generally said that the question of treatment of chronic duodenal ulcer is not settled I feel that the results of surgical treatment are as a rule, most satisfactory. I believe that the gastro-enterologist, the roentgenologist, the internist and certain surgeons who lack confidence in their work, are to a great extent responsible for the doubt as to the good accomplished by operative as against medical treatment. Personally I can say the longer I practice surgery the more confidence I have in its efficacy and the less in the medical treatment of chronic ulcer. The place which I give to the medical treatment of chronic ulcer is before the diagnosis is definitely established and after recovery from operation. This statement is based on a study of the non-perforative as well as the perforative ulcers on which I have operated. Nearly all of these patients have had medical treatment for years before they came to operation. It is a reflection on the profession that so many people, who many times have been pronounced cured of ulcer die from perforation or hæmorrhage. It is claimed that hæmorrhage

from an acute ulcer can be cured under medical treatment. This may be true for a large number of cases but not for all. It is also stated that recovery from hæmorrhage due to chronic ulcer takes place in the majority of instances. We all know of deaths due to hæmorrhage from acute ulcer and I have seen a number of cases of chronic bleeding ulcers that were medically treated to death. What I have just said is neither to discountenance medical treatment nor unduly to praise surgical treatment, but to give to each its proper merit. Medical treatment may often prove merely temporizing, to say the least. A good working rule is that the ulcer patient who fails to show decided improvement after one or two series of medical treatments should be confronted with the advisability of surgery.

Surgery in duodenal ulcer is not so urgent outside of the accidents perforation hæmorrhage and so forth, as it is in gastric ulcer, chiefly because of the risk of cancer in the latter which is rare in duodenal ulcer.

The type of surgery will, of course depend on the personal preference of the surgeon and on the presenting conditions. While gastrojejunostomy plays a prominent role as a surgical procedure it is not the only one at the disposal of the surgeon. According to the exigencies of the case such as size and location of the ulcer and other concomitant conditions he may merely excise the ulcer, or do a pylorotomy or a pyloroplasty or even a subtotal gastrectomy. Indeed wider resection was at one time and to some extent is still strongly advocated especially among European surgeons. It may have something in its favor but until sufficient data are at hand to prove that the more radical operation reduces the incidence or obviates the development of marginal ulcer the most serious sequel of gastrojejunostomy there seems no very valid reason *per se* for extensive gastric resection for duodenal ulcer.

Excision of a small duodenal ulcer is the simplest and would be the ideal operation if it positively insured the patient against future ulcers and if it were not for extensive and troublesome adhesions which may form after the operation. For these reasons it is often advisable to supplement excision by a posterior gastrojejunostomy. The small duodenal ulcer on the anterior or anterolateral wall can be treated by excision or by perforation with the cautery (Balfour operation) followed by posterior gastrojejunostomy. For a large ulcer on the anterior anterolateral posterior, or posterolateral wall of the duodenum, gastrojejunostomy alone may suffice, but ulcer of the

bleeding type requires excision or cauterization if possible, or a pylorotomy and a gastrojejunostomy. The results of these methods, however are sometimes minimized by the fact that these operations do not always effectively reduce gastric acidity, or if it is reduced the reduction the great desideratum of the operation, is not maintained. Posterior gastrojejunostomy alone is indicated when the ulcer is located low down on the duodenum close to the head of the pancreas as well as for ulcer obstructing the pylorus or the terminal duodenum. The latter fortunately, is rare.

Having dwelt on some of the disadvantages of medical therapeutics, it is only fair to call attention to the complications that may follow surgery. The most unpleasant and disheartening of these is of course marginal ulcer, which as we all know has the same inherent possibilities of hemorrhage and perforation as pertain to the primary condition. The incidence of marginal ulcer varies from 1 to 3 per cent or more. The cause may be faulty technique or ulcer diathesis that is the persistence of a hyperchlorhydria. But whatever its cause its incidence helps to keep the surgeon humble. The treatment of marginal ulcer is eminently surgical. The best procedure when the pylorus and duodenum are patulous is to cut out the anastomosis including the ulcer and periulcerous exudate close the opening in the stomach and anastomose the cut proximal and distal ends of the jejunum. Otherwise the procedure would be to undo the anastomosis and to perform a gastric resection either a sleeve operation or a subtotal gastrectomy. In the hope of avoiding

this sequel I have for the past 2 years or more been making fewer gastro-enterostomies. Instead, I have been removing the anterior half of the pyloric sphincter when feasible. This can be ideally done only if the ulcer is distant enough from the pyloric ring to make possible a complete dissection, but if the periulcerous exudate abuts the pylorus the muscle cannot then be completely removed.

The complete operation entails removal of the anterior muscular wall of the upper duodenum to a distance of a little less than one fourth of an inch from the pylorus as well as that of the muscular wall of the stomach to a distance of one half to three quarters of an inch proximal to the pylorus. In the small ulcer favorably located I have simply removed the anterior half of the pyloric sphincter. In the comparatively large ulcer in which the periulcerous exudate is not too extensive I excise the ulcer including the periulcerous exudate in addition to removing the muscle, terminating the operation by a gastroduodenostomy. I have done this in bleeding ulcer and in a few cases of acute perforated ulcer. The greater number of excisions of the anterior half of the muscle that I have made, however, have been for pylorospasm due either to gall stone disease or to hyperchlorhydria. The results have been satisfactory. The rationale of this operation is that it provides for better intermixture of the gastric and duodenal contents. This does away with a gastro-enterostomy, which is an advantage, especially as it does not interfere with making a subsequent gastro-enterostomy should the occasion arise.

## PSEUDOMUCINOUS CYSTADENOMA

ANALYSIS OF THIRTY CASES IN WHICH THE CYSTS WERE NOT RUPTURED BEFORE OPERATION

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**O**VARIAN pseudomucinous cystadenomata comprise a large proportion of the ovarian cysts with which the surgeon has to deal. According to the classification as given by MacCarty and Sistrunk the cystadenomata include the ovarian cysts which are lined by columnar or cuboidal epithelium and which contain highly albuminous material. Those which contain serous material are unilocular whereas those which contain soft gelatinous material or highly mucinous fluid that is, the pseudomucinous cysts are multilocular and have thin walls. The gelatinous material may show a mixture of yellow red gray or green depending on the degree of hemorrhage and on the amount of fatty material of cellular detritus or of cholesterol which is contained within the cyst. The epithelial lining may be hyperplastic and may be thrown into folds or papillae which have connective tissue pedicles and which are covered with epithelium continuous with that lining the cyst. The papillary growths may be intracystic or extracystic. When seen under the microscope the cells of the epithelial lining of the cysts may exemplify all stages of the process of secretion. Hertzler differentiated two main structural types of pseudomucinous ovarian cysts the papillary and the glandular and stated that the papillary type is more frequently bilateral.

The course of pseudomucinous tumors is slow. They may produce pseudomyoma peritoniei following spontaneous rupture of the cyst or following accidental rupture at the time of operation. As a result of such rupture and of the consequent spilling of the cystic contents into the peritoneal cavity epithelial cells may become implanted on the peritoneum and may continue to secrete. These tumors frequently are unilateral and pedunculated and grow to large dimensions. Ewing gave the occurrence of pseudomucinous cystadenoma as bilateral in 17.7 per cent of cases whereas Lehmann estimated that 50 per cent of women with a pseudomucinous cystadenoma in one ovary will have a similar tumor in opposite ovary. The tumors consist mainly of pseudomucina.

Wilson found 144 ovarian pseudomucinous cystadenomata in a series of 331 cases of ovarian

tumor in which he operated. Taylor stated that the frequency of pseudomucinous tumors is variously reckoned as from 30.6 per cent (Stuckler and Bravdes) to 53.6 per cent (Lippeot) and even to two-thirds (Pflanzenstiel) of all ovarian new growths of these only 6.7 per cent are said to be malignant. This same author carefully reviewed 139 cases of ovarian tumor in which he had operated. He found 6 cases of benign papillary pseudomucinous cystadenoma and 5 cases of mucous carcinoma graded 1. Probably 2 to 5 per cent of pseudomucinous cystadenomata as reckoned by different authors (14-15), give rise to the condition of pseudomyoma peritoniei.

Different ideas have been expressed as to the etiology of pseudomucinous ovarian cysts. MacCarty concluded from his histological studies of ovarian cysts that the pseudomucinous cysts develop by hyperplasia of the lining epithelium from simple cysts or from the stratum germinativum of the ovary. He found a small ovarian cyst with a lining which contained the many layered epithelium of the graafian follicle and simple cyst the columnar epithelium of the cystadenoma and the papilloma of the papillary cystadenoma. Goodall expressed the belief that pseudomucinous cysts not only are ovulogenic but that they also take origin from the germinal epithelium. Taylor in a recent article expressed the opinion that pseudomucinous cysts may perhaps be similar in ultimate origin to the serous tumors of the ovary but that there are elements in their etiology and pathology which justify their being considered as constituting an entity. He suggested that they may be of teratomatous origin. Mueller also expressed the belief that pseudomucinous cystadenomata are of teratomatous origin.

Usually when the ovarian cysts are removed at operation with an intact capsule the prognosis for cure is excellent. Occasionally there is recurrence even when the capsule is kept intact some times after many years. Olshausen reported a recurrence under such circumstances 17 years after the removal of the ovarian tumor and Lewis reported one 2 years after primary operation. Mayfield in a detailed analysis of 100 cases of

papillary cystadenoma, found 6 cases in which recurrence took place and in which the capsules of the cysts were said to have been intact at the time of operation. The presence of malignant tissue in the primary cystadenoma may be a significant factor in such recurrences.

#### ANALYSIS OF CASES

The histories of 30 unselected cases in which pseudomucinous cystadenomata of the ovary were surgically removed at The Mayo Clinic within the last 6 years were reviewed. The cysts were unruptured before operation. This number was chosen so that a comparison could be made with a study, given in another paper (11) of 30 cases of ruptured pseudomucinous cystadenoma which had produced pseudomyoma peritonaei. A questionnaire was sent to the 30 patients regarding their health at the time when they received the questionnaire. Replies were obtained from all but 4. The material was treated on a basis of percentage because it was thought that by this means the relative values could be more clearly brought out.

The average age of the patients was 48.4 years. The youngest patient was aged 24 years and the oldest, 71 years. The greatest number, or 11, were in the sixth decade of life; 7 were in the fourth, 6 in the fifth, and 4 in the seventh decades. In 8 of the cases the tumors were malignant as determined by microscopic examination. The average age of the patients with benign conditions was 46 years and the average of those with malignant conditions, 55 years. Seventy-three per cent of all the patients were aged more than 40 years. Sixty-three and six tenths per cent of the patients with benign conditions and 87.5 per cent of those with malignant conditions were beyond the age of 40 years. In 2 cases there was a family history of malignancy, but in neither of these cases was the cystadenoma malignant. Twenty-five of the patients had been married and 24 of them had had children. Twelve were past the menopause and 6 of these had had recent recurrences of uterine bleeding. In 72.3 per cent of 18 cases in which the menstrual history was given definitely, menstruation was normal and in 27.7 per cent there was a history of some irregularity previous to the menopause.

The symptoms in most cases were of gradual onset and included enlargement of the abdomen, increase in intra-abdominal pressure, a sensation of bearing down, urinary frequency, and dysuria. The complaint of increase in size of the abdomen was noted in 16 (53.3 per cent) of the cases. Abdominal pain, mostly in the lower quadrants, was



Fig. 1 Pseudomucinous cystadenoma showing typical honeycomb appearance.

complained of by 13 (43.3 per cent) of the patients, in 3 patients the pain was acute.

The duration of symptoms at the time the patients presented themselves at the clinic was given fairly definitely in 23 cases and averaged 20.2 months. Sixteen of these patients had benign cystadenomata and the average duration of symptoms was more than 2 years (25.8 months). In 7 patients who had ovarian tumors that on microscopic examination were found to be malignant the average duration of symptoms was only 7.7 months.

General examination revealed pelvic or pelvic and abdominal tumors which presented cystic characteristics in most instances. One of these tumors reached from the pubis to the xiphoid process of the sternum. Marked anemia was not present in any of the cases; the reading for hemoglobin usually was between 60 and 70 per cent (Dare).

At operation, either one or both ovaries were removed. In several cases the uterus, tubes, or appendix with associated fibromyomata or inflammatory disease and the affected organs were removed. In one case cholecystectomy for cholelithiasis was performed a few days after laparotomy. In 7 cases tenacious adhesions caused the cyst to be adherent to the surrounding structures. In 5 cases there was marked gross evidence of old pelvic inflammatory disease. In 3 other cases notable quantities of straw-colored, ascitic fluid were present; the quantity amounted to several liters in one case. The pseudomucinous cysts varied in size from that of a mass 6 millimeters in diameter to that of a mass larger than a normal pregnant uterus. Most of them were from 15 to 30 centimeters in diameter. In several of the cases in which the cysts were larger, marked thickening and injection of the peritoneal and





Fig. 2. Lining of pseudomucinous cystadenoma showing columnar type of lining epithelium.

visceral peritoneum were to be seen. The ovarian pedicle was long in several cases and it was definitely twisted in two. In 4 cases the pseudomucinous cystadenoma was unavoidably ruptured in the separation of adhesions and removal of the cyst (Figs. 1 and 2). In 2 of these cases cysts were microscopically malignant. In the cases in which the cysts were ruptured the spilled cystic content was removed as cleanly as possible and the region was thoroughly washed with physiologic solution of sodium chloride. In 6 cases the uterus contained single or multiple fibromyomata. In one case of malignant cystadenoma, there was a metastatic carcinomatous nodule in the body of the uterus. The patient in this case was 57 years old; she had had a foul bloody, vaginal discharge for 7 months previous to operation (Fig. 3).

The right and the left ovaries were affected in about equal proportion in cases in which involvement was unilateral. The condition of both ovaries was definitely known in 25 cases. Involvement with pseudomucinous cystadenoma was bilateral in 22, per cent of the cases in which the process was found to be benign on microscopic examination, and in 18 per cent of those in which it was found to be malignant. This gave bilateral involvement in 24 per cent of the cases.

In 26 (73.3 per cent) of the 30 cases the pseudomucinous cystadenoma was found to be benign on microscopic examination and in 8 (26.7 per cent), malignant. In the group of patients in whom the process was benign 6 had one normal or atrophic ovary. In these patients the other ovary contained a pseudomucinous cyst in 6 cases, a corpus luteum cyst in 2 cases and a simple cyst in 4 cases. Chocolate colored material

was in one of these cysts. In another case the simple cyst was associated with chronic oophoritis. In 1 case, there was papillary pseudomucinous cystadenoma in one ovary, and the other ovary was the site of chronic oophoritis associated with the presence of fibrous papillomata covered with epithelium.

In the group of patients who harbored a malignant process in one ovary, 2 had dermoid cysts in the other ovary, and in 2 the other ovary was senile or atrophic. In one woman who had a papillary carcinomatous pseudomucinous cystadenoma in one ovary there was chronic cystic oophoritis in the other. In 1 case one of the ovaries was the site of malignant papillomatous pseudomucinous cystadenoma and in the other ovary a pseudomucinous cyst but a malignant condition was not found.

Papillomata were seen on gross examination in 6 (27. per cent) of the benign pseudomucinous cystadenomata and in all of the malignant pseudomucinous cystadenomata. Broders is of the opinion that all growths which on microscopic examination are found to be papillary fibromyomata covered with layers of columnar epithelium are malignant. Unfortunately in only 2 of the cases in which a benign papillomatous condition involved one ovary was the condition of the other ovary definitely known. In both of these cases bilateral pseudomucinous tumors were present.

There were no postoperative deaths in hospital in the 30 cases. One of the patients with a benign condition had received roentgen ray treatment pre-operatively before coming to the clinic. Another woman, aged 71 years who had a bilateral papillary pseudomucinous cystadenoma was advised to have roentgen ray and radium treatment postoperatively. Five of the patients with malignant pseudomucinous cystadenomata had roentgen ray and radium treatment post-operatively.

Recent reports have been received concerning the health of 18 of the 26 patients who had benign conditions and concerning all 8 of those who had malignant conditions. The interval since operation in the group with benign conditions varied from 5 months to 6 years and 15 of the 18 patients were in excellent health and had no reason to believe that the pathological condition had recurred. In 3 cases however the state of health was questionable. One woman aged 56 years, who had undergone right oophorectomy for pseudomucinous cystadenoma 5 years and 4 months previous to the time when she answered our inquiry had gained 90 pounds in weight. She was not sure whether or not there was recurrence of

the growth. Another patient, aged 36 years, who 4 years and 7 months before she answered the questionnaire had submitted to bilateral partial oophorectomy for papillary pseudomucinous cystadenoma of one ovary and chronic oophoritis with papillomata of the other ovary, wrote that she had fluid in the abdomen. This probably denotes recurrence of the papillary tumor. A third patient, aged 40 years, who 3 years and 6 months before she wrote had undergone right oophorectomy for papillary pseudomucinous cystadenoma gave indefinite replies to the questionnaire. She affirmed that her old symptoms had returned and that she wished another operation.

The outcome in the 8 cases in which malignant conditions were present has not been so fortunate. The intervals since operation in this group have varied from 2 to 5 years. Two of the patients are dead. One, aged 59 years, died 2 years and 4 months after operation. The other, aged 61 years, died 3 years and 7 months after operation apparently from recurrence of the disease, she underwent left salpingo-oophorectomy for a papillary carcinomatous cystadenoma in the ovary and had not received roentgen ray and radium treatment after operation.

Five of the other women are in excellent health and have no reason to believe that the pathological condition has recurred. One patient, aged 57 years, who was operated on 4 years before she answered our inquiry wrote that she is confined to bed part of the time but that there is no noticeable enlargement of the abdomen. She submitted to panhysterectomy for carcinomatous papillary pseudomucinous cystadenoma of the right ovary, 7 centimeters in diameter, within which was a solid area of carcinoma 2 centimeters in diameter. A small quantity of the content of the cyst was spilled when the cyst was removed from the abdomen. The left ovary was normal. Also this patient harbored within the body of the uterus near the internal os a unique annular papillary carcinoma which was thought to have been caused by extension of the ovarian malignant growth.

#### COMMENT

In comparing the results of this study with those of the 30 cases of pseudomyxoma peritonei of ovarian origin it is seen that 50 per cent of the patients with pseudomyxoma peritonei had bilateral pseudomucinous cystadenoma of the ovaries, whereas the involvement was bilateral in only 24 per cent of the pre-ent series, in which the cysts were not ruptured. Also malignant conditions were present in only 26.7 per cent of the cases in which the cysts were not ruptured as



Fig. 3. Malignant pseudomucinous cystadenoma.

against 43.3 per cent of the cases in which the cysts were ruptured and in which pseudomyxoma peritonei developed. Odd as it may seem the average duration of symptoms before the patients came to the clinic was 20.2 months in the present series whereas in the series in which cysts had become ruptured the duration of symptoms usually was less than a year. This may be explained partly by the greater proportion of malignant cysts in the patients whose cysts ruptured and in whom pseudomyxoma peritonei subsequently developed. However, when a malignant condition is present in these cases it is usually of a low grade of malignancy (grade 1 or 2 according to Broders' classification). The average ages of the patients in the two series were approximately the same, namely, 48.7 and 40.9 years respectively.

The prognosis is usually good when the pseudomucinous cyst is removed before rupture, but even under this favorable condition recurrence can take place. One of the patients who had a benign, papillomatous cystadenoma leads one to surmise, from her answer to the questionnaire, that she has a recurrence. In 2 other cases, recurrence seems possible. Two of the women who had malignant conditions apparently have had definite recurrence. One of these patients has died.

The treatment of patients with pseudomucinous cystadenoma is surgical. The use of roentgen ray and radium after operation is advisable in those cases in which evidence of a malignant condition is found by microscopic examination. After menopause the removal of both ovaries is worth while even though only one of them appears to be involved with pseudomucinous cystadenoma. Bilateral removal is more urgent when

papillomata are seen grossly or when a malignant condition is found microscopically. If there has been postmenopausal uterine bleeding the uterus also should be removed. In cases in which operations for unilateral pseudomucinous cystadenoma are performed before menopause the attempt to save a portion of one ovary that may appear not to be diseased is of questionable benefit. One of the patients in the group with benign conditions and who possibly had a recurrence was treated in this manner. When it is necessary to save one ovary the surgeon should give due consideration to the type of growth in the affected ovary, namely, as to whether a malignant condition or gross papillomata are present. When a pseudomucinous cystadenoma is unavoidably ruptured at the time of its removal, thereby soiling the pelvis with some of the cystic content, the spilled material should be cleanly removed as far as possible and the pelvis thoroughly washed with physiologic solution of sodium chloride. Covering of the raw surfaces with peritoneum is an important measure.

## SUMMARY

Thirty cases of pseudomucinous cystadenoma of the ovary in which the cysts were not ruptured previous to operation are analyzed. The largest number of patients was in the sixth decade of life. The average age was 43.7 years. Seventy-three per cent were aged more than 40 years.

Twenty-two of the patients had tumors that were found to be benign on microscopic examination. Eight had evidence of a malignant condition in the pseudomucinous cystadenoma as revealed by microscopic examination. The average age of the patients who had benign conditions was 46 years and the average age of those who had malignant conditions was 55 years. Sixty-three and six tenths per cent of the patients with benign conditions and 87.5 per cent of those with malignant conditions were aged more than 40 years.

Swelling of the abdomen and pain were the most common symptoms. They were usually of gradual onset. The average duration of symptoms before the patients came to the clinic among those with benign conditions was 25.8 months, whereas among those with malignant conditions it was only 7.7 months.

The right or the left ovary was involved singly in about equal proportion. Bilateral involvement was present in 22.7 per cent of those cases in which microscopic examination revealed the condition to be benign and in 8 per cent of those in

which the condition was similarly disclosed as malignant.

Papillomata were visible to gross inspection in all of the malignant cysts. There is a greater tendency for bilateral involvement if papillomata are present. There was no operative mortality in the group.

The prognosis usually is good but recurrence may take place even though the cyst is not ruptured at the time of its removal. The removal of both ovaries is indicated if the women are past the menopause and especially if a malignant condition has been noted at microscopic examination or if gross papillomata are present. The uterus should be removed if there has been postmenopausal bleeding. The use of roentgen ray and radium after operation is advisable in patients in whom evidence of a malignant condition in the cystadenoma has been found on microscopic examination. If a malignant condition is found it usually is of grade 1 or 2 according to Broders' classification.

## BIBLIOGRAPHY

1. BRODERS A. C. Squamous cell epithelioma of the lip. *J. Am. M. Ass.* 1920 **xxv** 656-664.
2. Idem. The grading of carcinoma. *Minnesota Med.* 1923 **viii** 726-730.
3. EWING JAMES. Neoplastic diseases. 3d ed. p. 636. Philadelphia: W. B. Saunders Company 1928.
4. GOODALL J. R. The origin of tumors of the ovary. *Surg., Gynec. & Obst.* 1920 **xxx** 249-64.
5. HERTLER A. E. The Peritoneum. Vol. II pp. 81-831. St. Louis: C. V. Mosby Company 1919.
6. LEHMANN K. Pseudomyoma of the peritoneum. *Hosp. Tid.* 1926 **lxix** 326-333.
7. LEWIS ELIZABETH G. Pseudomyoma of the peritoneum. *Surg., Gynec. & Obst.* 1914 **xx** 751-60.
8. MAXFIELD A. L. Papillary cystadenoma of the ovary. *etc.* *Northwest Med.* 1927 **xvii** 236-243.
9. MCCARTY W. C. The histogenesis of carcinoma in ovarian simple cysts and cystadenoma. Collected Papers of The Mayo Clinic 1913 **v** 380-390. Philadelphia: W. B. Saunders Company.
10. MCCARTY W. C. and SISTRUP W. E. Benign and malignant ovarian cysts: a report of 1000 specimens. *Surg., Gynec. & Obst.* 1913 **xvii** 41-51.
11. MESSON J. C. and HARRISON R. A. Pseudomyoma peritonei: secondary to ovarian cystadenoma. *Canadian M. Ass. J.* (In press) 1930.
12. MILLER G. Pseudomyoma peritonei. *Bratislavské lékařské listy* 1924 **vi** 152-171.
13. OLSEN HANSEN R. Leber Metastasenbildung bei gutartigen Ovarialzystomen. *Zischr. f. Geburtsh. u. Gynaek.* 1894 **vi** 238-245.
14. TAYLOR H. E. Jr. Malignant and semimalignant tumors of the ovary. *Surg., Gynec. & Obst.* 1929 **xlvi** 204-230.
15. WILSON T. Gelatinous glandular cysts of the ovary and the so-called pseudomyoma of the peritoneum. *Proc. Roy. Soc. Med. Sect. Obst. & Gynec.* 1912-1913 **vi** 9-42.

## CONGENITAL DISLOCATION OF THE HIP

DIAGNOSIS AND A NEW METHOD OF TREATMENT IN INFANCY<sup>1</sup>

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THE subject of congenital dislocation of the hip is one of extreme importance, first on account of the great deformity and disability which are the fate in untreated cases, second, the low percentage of cures and the unsatisfactory results of the so called conservative treatment. By conservative treatment I mean the attempted reduction of the dislocated head under an anæsthetic and the application of a plaster of Paris cast. According to present practice, conservative treatment is started late, rarely before the third year of life. The poor results are due to the malformations of the head, the neck, and the acetabulum during the period of rapid growth in early childhood, to the constriction of the capsule which often makes it impossible to pass the head through, while making the manipulative reduction, and to the damage to the bony structures which may occur during the operative manipulation.

Galloway states that in the hip joints he has opened, it was clearly a physical impossibility to pass the head through in at least 95 per cent of the cases.

In opening a symposium on congenital hip dislocation at the annual meeting of the American Orthopedic Association held in Washington in May, 1928, Allison says: 'In the last 10 years a recognition of the possible damage done to the growing upper femoral epiphysis by manipulation has been slowly established. This fact is of great importance. It is realized also that the growing upper end of the femur may be seriously damaged by the force applied in attempts at the time of the manipulative reduction.'

Farrell says: 'I am going to agree with Dr Allison that the results in congenital hips throughout the country are far from satisfactory and that the percentage of cures is very low, much too low for a condition that is as common as congenital hip.'

Gill says: 'The obvious reason for early reduction is that growth and development so change the upper end of the femur (I would also add the acetabulum) that reduction becomes increasingly difficult. The constant trauma of function in the unreduced hip also produces marked changes in the growing epiphysis.'

To all these early pathological changes must be added those that come on later in life. Osteochondritic and severe arthritic changes (Kreuz, Scholz, Calot). A case has been reported in which a perfect anatomical cure had been achieved, but 7 years later an X-ray examination revealed the total absorption of the femoral head. These poor results have started such a wave of operative procedures that some men will treat their cases only by open operation.

In this relation I will again quote Farrell: 'Personally I am rapidly coming to the conclusion that open operation is much preferable to manipulation unless the reduction can be done with very little trauma. Allison says: "One fact stands out clearly in a discussion of this question, namely, it will be by open operation, by early operation, and by gentle operation that the results in congenital dislocation will be improved."

Farrell, von Lackum, and Smith state: 'We believe that personally every congenital dislocation of the hip within a reasonable age limit can be reduced by open operation, and in this way improved. The results in this series of cases compel us to believe that a much larger percentage should be reduced by open operation than was so treated.'

Mr Harry Platt, of Manchester, England, says: 'At the present time there is a growing dissatisfaction with the anatomical results of closed reduction, and we appear to be on the eve of a revival of the open operation in young children.'

Stephens reviewed the end result of the treatment of congenital hip dislocation. The cases embodied in the report were all treated as indoor patients at the Hospital for Ruptured and Crippled during a period of 20 years. He says:

'From this we might infer that the percentage of cures might be even less than fifteen. And further, if the percentage of good results is not markedly increased, then we might conclude that our methods of treatment have been unsatisfactory and should be changed.'

As a last authority I will quote Dr David Silver discussing Dr Allison's paper: 'Hope of future improvement. Dr Allison said if I understand him correctly, it is to be looked for in open



Fig. 1. Roentgenograms of Case 1 before treatment, at the end of treatment, and 4 years later. Note the late ossification of the dislocated head.

operation. This statement appears to me to be absolutely wrong. Hope for future improvement lies in early recognition. Since structural adaptation becomes increasingly greater as the child grows, and hence the degree of function to be looked for, it becomes correspondingly less what ever the method of treatment used. Would it not be wiser for us to devote less time to the discussion of the relative methods of the closed and open methods, and concentrate our energies on efforts to secure diagnosis as early as possible?

I wish to tell how to make the diagnosis in infancy and having made it, how to apply a treatment that will avoid all deformities, complications, and the long and painful treatments of my own treatment, which can be applied without discomfort to infants as young as 3 or 4 months of age, will bring about a physiological restoration of the affected joint within as short a time as 3 months. By means of this treatment anesthesia, manipulation, open operation and plaster-of-Paris casts are all avoided.

I will not discuss the theories advanced as to the causes of congenital dislocation of the hip. My own conviction is that there is sufficient displacement in very early life to cause pressure of the femoral head against the upper rim of the acetabulum, which pressure prevents the growth of the upper rim. Removal of this pressure is promptly followed by development of the upper rim of the acetabulum.

In the first months of life, growth and development are very active. A familiar phenomenon of birth fractures is that callus is thrown out quickly and in amazing quantity. I will demonstrate in the X-ray pictures of my cured cases how bone formation begins soon after removal of the resistance which retards it.

#### DIAGNOSIS

Several points may be mentioned in the diagnosis of unilateral cases.

1. Habitual outward rotation of the affected leg.
  2. Shortening of the affected leg. This is often seen by inspection and may be ascertained by comparative measurement of both legs from the anterior superior spine to the inner malleolus. Another test for shortening is this: Lay the child on a hard smooth table and (a) flex both hip joints to 90 degrees and with the knees flexed the knee of the affected leg will then be at a lower level.
  - (b) With hips flexed as above, fully extend the knees. In this position the shortening which was apparent with the legs extended becomes more marked. There is in addition tension of the tubercrotal muscles and an absence of resistance backward.
  3. Fullness over the trochanter causing an apparent widening of the pelvis on that side.
  4. Abnormal mobility of the hip, especially in rotation (a very important sign).
  5. Very noticeable difference in the inguinal folds. On the affected side the fold is shorter, the angle is changed (being more vertical) and the inferior inner end is higher than on the normal side.
  6. Exactly the same change in the gluteal folds as in the inguinal folds.
  7. The diagnosis is verified by the roentgenogram.
- In the bilateral cases we find
1. The same signs as in unilateral cases except that the inguinal and gluteal folds offer no help.
  - Habitual outward rotation of both legs.
  3. The pelvis is comparatively wide.



Fig. 2. Roentgenograms of Case 2 taken before treatment, 5 weeks after brace was applied, and after 4 months of treatment. Note the late ossification of the dislocated head.

4. No lengthening of the measurements from the anterior superior spine to the external malleolus as in normal hips when both legs are forcefully abducted but instead an equal distance or even a shorter distance than if the legs were lying parallel.

5. A sort of crackling or click, which occurs spontaneously when the legs are moved especially when they are abducted and then extended. This sign, which has been described by Hoffa, is believed to be due to the rubbing of the femur against the posterior margin of the acetabulum within a loose capsule.

6. The diagnosis is confirmed by the X-ray plate.

#### TREATMENT

For years I have had in mind a new form of treatment based on an entirely new principle. This treatment should be begun in earliest infancy. Without force or violence without an anesthetic, it is my aim gradually to replace the dislocated head in the socket by means of a pressure pad over the trochanter while the leg is held in marked abduction by means of a long hip splint. I hope thus (1) to prevent the deformities that inevitably develop, (2) to make use of the very rapid growth in infancy to aid in the formation of a socket, and (3) to reduce the dislocation without traumatism, thus avoiding the consequences of rough manipulation.

I am indebted to Dr. F. Elmer Johnson of New York City for the opportunity of treating my first case, and I wish to compliment him for having made the diagnosis of a hip dislocation in a child 3½ months of age. A brief history of the case follows:

\*This case was reported at the treatment described in a paper read at the meeting of the orthopedic section of the New York Academy of Medicine, May 15, 1915.

CASE 1. J. R., a female child aged 3½ months was the first child of a first pregnancy which terminated in a full term normal labor. There is no history of congenital dislocation of the hip in the family. The patient weighed 3½ pounds at birth. Dr. Johnson noticed preternatural rotation of the right leg and 1 centimeter shortening. He made the diagnosis of congenital dislocation. The child was in such delicate health and its condition so poor that no X-ray picture was made until 2 months later. This picture made at the Babies Hospital confirmed the diagnosis. On May 7, 1921, the patient was seen by the late Dr. Frauenthal who advised reduction and plaster of Paris cast for the hip. The baby, still very delicate in health, was not referred to me until the age of 7 months when it was considered treatment might be begun. I suggested my plan to the parents. Further advice was sought and Dr. Royal Whitman examined the child. He suggested waiting 2 or more years until the child was of an age suitable for reduction and plaster cast. When the parents told him of my plan for immediate brace treatment, he advised the parents to let me try it.

I began the treatment in this manner. A long hip splint of rustless steel was designed. This splint consisted of two circular bands to fix the pelvis and chest, two lateral bars to support the leg to the lower end of the bars was attached a footplate with a leather anklet. This maintained the midposition of the leg, i.e., it was in neither outward nor inward rotation. The long outer bar was bent to fit the leg at 45 degrees abduction. There was no provision for traction or extension because I deem it entirely unnecessary to subject a child to the inconvenience and irritation of the traction straps, and besides nothing is gained by their use.

In order to accomplish the gradual reduction of the dislocated head, I depend upon an adjustable pad controlled by a wing screw about 1.5 inches long placed directly over the trochanter. The pad pressing downward and inward gradually and easily directs the head into the acetabulum.



Fig. 3 The asymmetry of the inguinal and gluteal fold of right side is shown

The infant wore the brace continuously and this necessitated the substitution of sponge baths for tub baths. Notwithstanding this handicap, and that this period included the warmest months of the year the child developed rapidly and was in excellent physical condition. This shows beyond doubt that my treatment does not in any way retard the normal development of the child.

In this case I applied pressure very gradually over a period of months. I considered the comfort of the patient of greater importance than speedy reduction. The brace was applied on May 24, 1924. It was worn until February, 1925, a period of 8 months. On account of the rapid growth of the child, it was necessary on two occasions to remove the brace and substitute a plaster spica for a few days while the brace was being lengthened. The X-ray pictures taken at intervals of 2 weeks showed a progressive approach of the upper end of the femur to the acetabulum and a gradual development of the upper rim of the socket which was definitely apparent 4 weeks after the brace was applied. Toward the end of February the long brace was removed and a short abduction splint without the trochanter pad was applied.

In this my first case I was unnecessarily cautious in applying the pressure to the trochanter. It would have been perfectly feasible to bring the head into the socket within 4 weeks. Further more I left the brace on for several months longer than actually necessary. This child is now walking about without any limp or shortening or any sign that there has ever been anything the matter with her. The X-rays taken 4 years after the conclusion of the treatment show two normal acetabula so completely alike that it is impossible to tell which hip had been dislocated.

**CASE 2.** L. A. female first and only child. Nothing abnormal was noted until she was 13 months old. After the child had been walking 1 month the mother noticed a limp and she took her to the Hospital for the Ruptured and Crippled. There the diagnosis of congenital hip dislocation was made. Reduction under an anesthetic and a plaster of Paris cast were advised. The parents did not agree to this. Within 2 weeks they took the child to a private physician who also advised admission to the hospital, reduction of the dislocation and the application of a plaster of Paris cast. After seeing the X-ray plates however he said he would treat the child in his office without an anesthetic and without manipulation. A plaster of Paris spica was applied with the leg in slight abduction and kept on for 8 weeks. Three more spicas were applied with the leg in various positions for a period of 6 months. Then a brace was applied. This was a Thomas knee splint with leg attachment. The brace was used for 6 months. During this whole year the child was allowed to walk. At the end of the year's treatment the X-ray plate showed that the head was not in the socket although with traction applied to the leg the head could be brought down to the level of the acetabulum but it was separated a goodly distance from it. The mother was then notified that an operation including bone transplantation should be performed. This procedure was declined.

The child then came under my care when she was 2 years and 7 months old. I found the left hip still dislocated as shown in the X-ray picture (Fig. 2). A brace was ordered and at Christmas in 1928 was satisfactorily fitted and applied. This brace was similar to the one used on my first case. The screw pressure was applied to the trochanter more rapidly than in the first case and within 5 weeks the dislocated head was in the socket and has been there ever since. The patient was not allowed to walk during the entire time of the treatment. The brace was worn a little over 4 months.

I did not permit the child to walk for the following reasons. The frequent X-ray pictures showed that the socket was developing so well without weight bearing that I wished to challenge the theory advanced by Lorenz and others, that functional weight bearing is necessary for deepening the acetabulum. To my mind the main requisite for deepening the acetabulum is the removal of the pressure of the head from the upper rim. The X-ray pictures all show how rapidly this rim develops as soon as the trochanter pad has pushed the head down into what is to become the socket. I also feel that when the head is surrounded by a well developed acetabulum the traumatism of weight bearing will be less and that no damage will come to the head in later years. This damage has been seen with persistent regularity in cases treated by the method now in general use in which a soft cartilaginous head is supposed to pound out a hollow in the harder bony socket.

Case 2 has been very instructive. It shows that the trochanter pressure can be applied without inconvenience strongly enough to bring the head into the socket within 5 weeks. And this was

accomplished in a child 2 years and 7 months old. The development of the upper rim of the acetabulum in Case 2 progressed satisfactorily. You will see in Figure 2 how a curve is beginning to appear in what will be the roof of the socket. All of this shows that while the ideal time for treating these patients is the earliest months of life the method has been found equally effective in an older child.

These two cases had single dislocations. I am anxiously awaiting the opportunity to test the method in cases with both hips dislocated because we know that the prognosis in bilateral dislocations is not as good as in single dislocations. With my method I am confident that the treatment will be equally as successful in bilateral as in unilateral dislocations.

#### SUMMARY

It should be our duty to emphasize the fact that congenital hip dislocation can be diagnosed in the first 3 months after birth. This is important alike to the family doctor and the pediatrician.

The present method of handling these patients is unsatisfactory. Now, treatment is begun too late, for when treatment is delayed serious bony changes take place thus making reduction and retention difficult.

As to the closed method of treatment, this means of reduction must necessarily damage all the structures making up the hip joint. This damage is progressive and leads to further deformities and to disability in later life.

Regarding the surgical treatment some authorities advocate and use the open operation in every case. Such treatment requires much time—sometimes 9 months to several years—and the

result is uncertain. It requires repeated narcotics, the patient suffers much pain and inconvenience, and the method is not entirely free from danger to life.

The physiological treatment which I have just described is simple, is applied with little inconvenience to the patient, assures normal development of the femur in the acetabulum, furthermore it requires much less time than the other methods—no more than 3 months—and if the treatment is properly carried out, should result in a high percentage of cures.

#### REFERENCES

1. ALLESON, NATHANIEL. The adaptive changes in the hip in congenital dislocation and their importance in treatment. *J Bone & Joint Surg.* 1928 x 687.
2. AMERICAN ORTHOPEDIC ASSOCIATION. Report of special commission on congenital hip dislocation. *J Bone & Joint Surg.* 1921 viii 353.
3. CALOT, F. So-called osteochondritis of the hip as unrecognized congenital dislocation of the hip. *Monde méd.* 1918 xxxviii.
4. FARRELL. Symposium on hip dislocation. *J Bone & Joint Surg.* 1928 x 700.
5. FARRELL, VON LACKUM and SMITH. *J Bone & Joint Surg.* vol ix.
6. GILL. Symposium on congenital hip dislocation. *J Bone & Joint Surg.* 1928 x.
7. KRETZ. Early diagnosis of congenital dislocation of hip. *Verhandl d deutsch orthop Gesellsch.* 1926 p 399.
8. PLATT, HENRY. Symposium on congenital hip dislocation. *J Bone & Joint Surg.* 1928 x 707.
9. SCHOLZ, A. Roentgen study of osteochondritis deformans coxae juvenalis and congenital subluxation of hip. *Arch Orthop.* 1923 xxvi 372.
10. SILVER, DAVID. Symposium on congenital hip dislocation. *J Bone & Joint Surg.* 1928 x.
11. STEPHENS, RICHMOND. A review of the end results of the treatment of congenital dislocation of the hip. *J Bone & Joint Surg.* 1928 x 541.



## FOUR RARE RECTAL TUMORS

INTRARECTAL SOLID TERATOMA, FIBROLEIOMYOMA, PARAFFINOMA, AND CHORIOBLASTOMA<sup>1</sup>

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**T**HE purpose of this paper is to report four cases unrelated except in that they are rectal lesions of rare occurrence and are interesting pathological types.

## INTRARECTAL SOLID TERATOMA

Dermoid cysts and tumors are not uncommon and the supposedly related teratomata are scarcely rare, but the particular tumor about to be described must be considered a most exceptional lesion. In an extended search, only three descriptions of similar tumors were found, and references not accessible to a few others were encountered. Whether these latter are actually identical cannot be stated without study of the original articles, not so far available to us.

**CASE 1.** Mrs. M. L. C. white aged 35 years complained of hair growing from anus. She has been forced to cut this off at intervals and this has been going on for the past 8 years. She was very constipated had some discomfort in rectum if she sat for a long time and had pain in lower spine. No mass protruded from the anus and there was very little bleeding. On examination a strand of long fine straight dark brown hair was seen protruding from the anal orifice. The hair on the patient's scalp, pubis and perineum was blond. On rectal palpation an ovoid mass firm movable about the size of a large plum could be felt. This mass was fixed by a broad pedicle to the posterior rectal wall about 10 centimeters above the anal margin. With the proctoscope an ovoid white tumor could be seen just above the lowermost rectal valve from which hair was growing. Operation was advised and on April 3, 1928 was performed at the Union Memorial Hospital under ether anesthesia. The phlegmon was widely dilated and the tumor mass exposed. The mass was about 5 centimeters in diameter. It was connected by a pedicle 4 centimeters long to the back of the rectum about the level of the third sacral vertebra. This pedicle passed directly through the rectal wall and was covered with white skin. The red mucous membrane of the rectum formed a sharp contrast to the white skin of the tumor pedicle. The rectal mucosa was divided from the pedicle on all sides and the pedicle was dissected backward behind the rectal wall as far as its attachment to the fibrous tissue in front of the sacrum. A clamp was put across the base at this point the pedicle was divided and the tumor was removed. The base of the pedicle was then transected with a suture above the clamp and tied off. The open cavity thus made in the posterior wall of the rectum was packed with dry gauze which was brought out through the anal orifice. The patient left the table in good condition and made an uneventful recovery. At the end of 3 weeks the wound made in the posterior rectal wall had completely healed and the patient was discharged as cured. She was seen 8 months later and was entirely well.

**Gross pathology.** U. M. 2232 C. H. I. 966. The tumor is comma shaped and smooth with small patches of delicate long brown hair growing on the under surface and sides. The head of the comma measures 5 by 3.5 by 4 centimeters while the tail measures 4 by 1.2 centimeters. On section the entire tumor is found to be surrounded by a well defined layer 2 millimeters thick which is radially striated. Beneath this the tissue consists of mottled white bands interspersed with irregular lemon colored areas. I projecting above the surface at about its center is a pearly white hard object 3 by 2 millimeters which looks very much like a tooth or piece of bone.

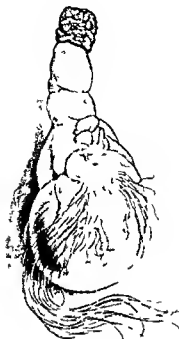
**Microscopic examination.** The tumor is surrounded with cornified squamous epithelium. The germinal layer dips deep down into the corium. The main body of the tumor is made up of bundles of smooth muscle and connective tissue but there are also alveoli of fat racemose sweat glands bone nerve fibers and hair follicles.

The tumor removed is well presented in its anatomical relations, its size gross appearance and cut surface by the accompanying sketches which also illustrate the steps of the operative removal (Figures 1, 2, 3, 4, 5, and 6). In short this tumor is a teratoid mass of mixed tissue, but unlike an ordinary dermoid is not cystic, and instead of being a cavity lined with skin is a solid mass covered with it. Further, it did not lie before or behind the rectum but swung free in the lumen of the bowel attached by its pedicle to the posterior rectal wall. As has been said dermoids and teratomatous tumors are not especially rare, and one of the regions where they are apt to occur is in the rectal environment behind the bowel near the coccyx or in the rectovaginal septum. Such cysts in rare instances may rupture into the bowel.

Maingot and Saphir report such cases in each the trauma of labor being the cause of the rupture. In Maingot's article the tumor passed per rectum was described as consisting of a mass with four distinct cysts, not communicating and containing caseous material hair unstriated muscle epithelium cartilage and fibrous tissue. A lacinated surface on the anterior rectal wall was thought to be the point of attachment of the tumor. Saphir's patient discharged a mass of hair and sebaceous material per rectum during labor and later a rent was seen in the anterior rectal wall which opened into a cyst cavity lined with a hair growing wall. Saphir refers to several other similar reports in the literature.

<sup>1</sup>We have been aided in the preparation of this work by a grant from the Hartley Foundation.

Didusch '28



Didusch 1928

Fig 1. Excised teratoma of rectum

Danzel, Port, and Bensaude and Rachet each report one case very similar to the one herewith recorded. All of the patients were women. Their ages were 16, 25 and 39 years respectively. In each instance hair growing from the anus was the symptom that attracted attention. Danzel operated on his case and removed a tumor 4.5 by 4 by 3.5 centimeters which contained a tooth, much hair, bone, fat, and rudimentary brain tissue. The patient died over 3 months later from a slow perforation through the anterior rectal wall where the tumor had been attached.

Port's patient finally extruded the tumor per anum, and its pedicle was then ligated and the mass removed. It was a mass 2.5 by 2 by 1.5 inches covered with ordinary skin growing hair and containing fat, bone, a tooth and muscle fibers.

Bensaude and Rachet did not remove the mass but saw it through a proctoscope and described it as a mass the size of a cherry, of a pinkish white color growing hair from its surface and attached to the anterior rectal wall 13 centimeters above anus. These writers refer to a

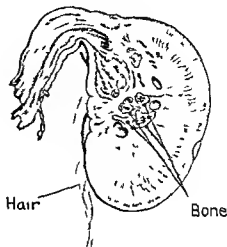
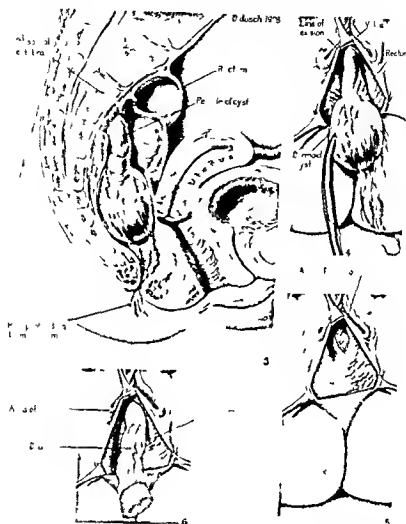


Fig 2. Teratoma cut surface

thesis by Salmonoff (Berlin 1902) who reports eight dermoid cysts above the anus, two of which had produced hair protruding through the anus. Neither of these was operated on as the symptoms did not seem to warrant it. They also quote Longuet who in 1898 reported 3 cases, but no details are given.

There are a few comments to be made on this assembly of cases. All are in women and all in the earlier half of life. In all the symptom complained of was hair protruding from the anus. In several there was some difficulty in defecation. No bleeding is reported in any case. Siphir's case of ruptured cyst suggests a possible explanation of the evolution of the form of tumor here considered: a tumor or cyst lying close under the rectal mucosa which ruptured into the lumen would if it continued to grow perhaps protrude into the bowel as a skin covered, hair growing mass. In other words a dermoid or teratomatous cyst which ruptured into the bowel might, by continued growth, turn inside out and its hairy skin lining would then become its covering. As to treatment, although surgical removal may at times seem a formidable problem, no other method offers a satisfactory solution. If the patient suffers little except the annoyance of the protruding hair and the tumor is so situated as to render operation exceptionally difficult or dangerous, good judgment would naturally lead one



Figs 3 4 5 and 6 Teratoma of rectum

to defer interference until it should become more clearly indicated

#### FIBROLEIOMYOMA OF RECTUM

Fibrous tags about the anus resulting from organized thrombosed hemorrhoids or enlarged and fibrous skin folds are of course exceedingly common. Polypi in the anal canal and rectal lumen of small or moderate size with a fibrous stroma and epithelial covering are often seen. On the other hand true rectal tumors of distinctly neoplastic character as distinguished from chronic inflammatory or hyperplastic masses of tissue, that consist of smooth muscle or fibrous tissue or a mixture of both are very rare indeed.

Thus Ashton in 1865 quotes only one case a fibrous tumor weighing one half a pound growing from the anal margin. Tuttle says that true fibromata of the rectum are exceedingly rare and refers to two cases in the literature neither of them his own. Ball mentions fibromyoma as being a very rare rectal growth and reports one case. Gaut does not remember encountering a typical myoma of the anal region but states that fibromyoma are occasionally met with in the rectum or recto-vaginal septum. Hill reports seeing only one case of myoma. Lynch reports records in the literature of 80 cases of myoma of the entire intestinal tract of which number 10 per cent or 16 cases occurred in the rectum or



Fig. 7 High power photomicrograph of rectal teratoma showing sweat glands and cross section of hair

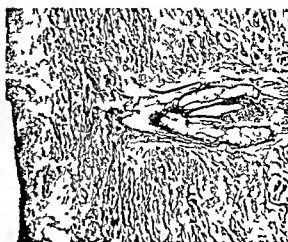


Fig. 8 High power photomicrograph of rectal teratoma showing root of hair follicle and surface epithelium

anal region. These are all references from textbooks written by specialists in the field of rectal surgery, men of wide personal experience and familiarity with the literature. Hunt in a special study of such cases published in 1921, reports 4 cases of his own, 2 of pure myoma and 2 of fibromyoma. In an extensive review of the literature he could find only 20 cases reported since 1872 that he accepts as myoma or fibromyoma. From his own cases and those collected he summarizes the few following data: 13 patients were women, 10 were men, and in 1 instance the sex was not recorded. The age incidence ran from 21 to 85 years. Malignancy developed in one case. He gives brief abstracts of all the cases from the literature and adds the record of his own 4 cases. Wolfer in an article on leiomyomata of the intestinal tract points out that rectal myomata may protrude into the bowel like polyps or grow outward from it usually behind toward the hollow of the sacrum. He refers to such a case reported by Senn, which weighed 1 pound.

It will be seen from the survey of the subject that we are dealing with a very unusual tumor of the anorectal region. Such tumors need to be borne in mind because of the possibilities they present for mistakes in diagnosis. Our case had been misdiagnosed before coming into our hands and our own recognition of its exact nature awaited the operative and histological findings. As seen by reference to the reported cases, the

most common error is to mistake these essentially benign tumors for malignant disease, with the danger of being led into an extensive destructive operation unnecessarily.

The report of our case follows:

**CASE 2.** Mrs. I. A. C. aged 74 years had complained at intervals for several years of rectal trouble. For the past 2 months this has been more acute. There has been a good deal of pain in the anal region and difficulty in securing bowel movement, feeling of pressure and occasionally

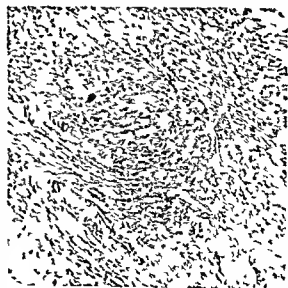


Fig. 9 High power photomicrograph of rectal fibromyoma showing bundles of smooth muscle and fibrous tissue

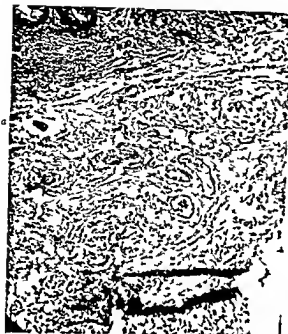


Fig 10 High power photomicrograph of rectal paraffinoma showing intact mucosa, pseudo tubercles with giant cells and rarefied tissue about them. At a there is a small hyaline area interpreted as paraffin.

the passage of some blood or mucus. There has also been some aching in the back and down the legs. Six weeks ago she consulted another physician who found a swelling back of the anus which was taken to be an abscess and this was incised. The wound did not heal properly although no pus was found at the time of incision. The mass still persisted as before. On examination there was found an incision in the posterior midline just behind the anus with curious looking base and punched out edges. The base was firm rather gelatinous looking with a tendency to bulge upward into the wound. Prebiliary diagnosis was possible colloid carcinoma. A few small hemorrhoids were also present.

Operation was advised and on November 19 1927 was performed at the Church Home and Infirmary, ethylene gas anesthesia being used. The wound already existing was enlarged and a large tumor was found underlying it. This tumor was completely and firmly encapsulated and it shelled out of its capsule very readily with very little bleeding. It formed an ovoid mass 6 centimeters long by 4 centimeters wide. There was a good sized cavity left by its removal which was partially closed by bringing the sphincter and levator muscles together from the two sides with interrupted catgut sutures. The remainder of the wound was packed with iodoform gauze. A naked-eye inspection of the cut surface of the tumor led to a diagnosis of fibroma as is shown in the pathological report which is given below. The wound healed very quickly and very cleanly.

The patient's constipation was greatly improved following operation and the pain in the back and down the legs disappeared. Patient was seen about a year after operation and there was no evidence of recurrence.



Fig 11 High power photomicrograph of chordoma showing large polygonal cells arranged in strands with occasional syncytial masses and foam cells.

**Gross pathology.** Section No 8100. The specimen consists of a hard oval encapsulated mass measuring 6 by 4 centimeters. The mucous membrane is ulcerated down to the muscularis. Its base is smooth and clean. Section through the mass shows a thick capsule surrounding it. The tissue is a uniform grayish pink with the fibers arranged in whorls.

**Microscopic examination.** On examination under the low power the section has the appearance of a fibromyoma of the uterus. There are strands of hyalinized connective tissue interspersed with whorls of smooth muscle fibers cut at various angles. Large venous sinuses are present and there are occasional smaller arteries with thick hyaline walls.

#### PARAFFINOMA OF RECTUM

No record of any case like this one has been found in a fairly extensive search of the literature. Paraffinoma of course is a lesion of definite etiology and the history of this patient makes it quite evident that the treatment he must have received for hemorrhoids consisted of the injection of paraffin into the rectal wall. The history of the patient follows:

**CASE 3.** Mr R Z D aged 67 years. Patient used to be troubled with hemorrhoid which protruded but did not bleed much. In May 1926 he had these hemorrhoids treated by an injection method. The patient does not know what the material injected was. Following the injection there persisted some tenderness and swelling. The complaint at the present time is persistent and increasing constipation which has become very pronounced during the last 2 or 3 months. There has been no rectal bleeding, no pain and no definite tenesmus. No nausea, vomiting or abdominal cramps and no loss of weight. There have been no bladder disturbances of any kind. The principal and only complaint is extreme and increasing constipation. On examination nothing was made out in the abdomen. Rectal in section was also negative. Rectal palpation however showed an annular constriction just above the anal canal about at the level of the apex of the prostate gland. This constriction was quite hard, fixed, with well defined edges and a smooth surface. With the proctoscope the lumen of the bowel was seen to

be reduced at the level of the stricture to about one half of its normal diameter. The mucous membrane at this point looked normal and no ulcerations were seen. Diagnosis was rectal stricture due to a tumor like mass of angular form not involving the mucous membrane. A preliminary diagnosis of sarcoma of the bowel wall was made but as this was by no means a strongly held opinion it was decided on March 15, 1928 to remove a specimen for microscopic study. The report from this small piece of tissue was tuberculosis of the rectal wall. As the lesion was strictly localized the patient was advised to have an operation done for the removal of the diseased area.

Operation was performed at the Church Home and Infirmary March 17, 1928 ethylene gas anesthesia being used. A circular incision was made at the anal margin and prolonged backward in a straight line toward the coccyx. The coccyx however was not removed. The sphincter muscle was carefully dissected away from lower portion of the bowel and preserved in place without being divided. The bowel including the mass in its wall was then dissected loose from the surrounding structures up as high as the peritoneal cavity which was not opened. The whole rectum was thus mobilized. The bowel was then drawn through the sphincter and the distal portion amputated a margin of about 1 inch being allowed above the area involved in the disease. The proximal stump of the rectum was then sutured into the anal skin as in a Whitehead operation. The patient left the table in good condition. His wound healed quite well although it was several weeks before he regained control of his sphincter muscle. At the present time his control is practically perfect. The microscopic examination of this tissue showed very interesting further development.

**Gross pathology.** The specimen is that of the lower portion of the rectum extending 7.5 centimeters from the anal margin. When the lumen was opened the mucous membrane appeared intact. Beneath the mucosa extending into the submucosa and muscularis is a hard circular cuff which on section consisted of gray fibrous tissue in which were hard clear transparent gelatinous and yellow fatty areas. Two glands about a millimeter in diameter removed from the external surface of the rectum were also present. These showed no abnormality in the gross.

**Microscopic pathology.** The mucosa over the entire section was intact. Just beneath this the tissue was heavily infiltrated with small round cells and from here down through the muscular coats were structures which at first glance gave the impression of tubercles. The tissue in these places seemed rarefied. The cells are stellate with fine fibrils connecting each with the other. Giant cells are present in large numbers some of them within the pseudo-tubercles and others loose in the muscle with practically no cellular reaction about them. They are characterized by having their nuclei grouped at their centers. Nowhere is there any evidence of caseation and there is usually no round cell reaction about the tubercle like structures. Dr. James Ewing saw the section and makes the following comment: "The section of rectal tissue which you sent me looks like a paraffin tubercle. I think the patient must have had an injection of paraffin which produced this chronic progressive productive inflammation. There are a few hyaline areas which were found after long search which we are willing to call droplets of paraffin."

The point of paramount interest here aside from the unusual employment of paraffin injections in the treatment of hemorrhoids was the

difficulty of diagnosis. It must be remembered that no statement was obtained as to the material that had been used for injections and that a considerable time had elapsed since the injections had been given. The case presented certain features suggesting that the easily felt stricture was a malignant growth. The annular mass was very hard and inelastic and fairly fixed to surrounding structures. On the other hand, it lacked the ulcerated nodular surface that a carcinoma of this size would be expected to present. The smooth intact mucosa over the mass did not suggest a tuberculous process either, and the preliminary diagnosis was sarcoma of the deeper structures of the rectal wall, without invasion of the mucosa. It was because of the unsatisfactory nature of this diagnosis that a biopsy was done before attacking the lesion surgically. The biopsy report of tubercle eliminated the question of malignancy and settled the type of operative procedure in favor of local resection rather than radical excision of the rectum. When the whole specimen was examined it was clear that the tubercle formation was of the foreign body variety and not due to infection with the Koch bacillus.

#### SACROCOCCYGEAL CHORDOBLASTOMA

Within the past few years the subject of tumors developing from the notochord has received a good deal of attention, as is evidenced by the carefully prepared case reports and reviews of the literature. In this paper we make no attempt to review the literature, as those who are interested may refer to the publications of Albert, Capell, Stewart, Hutton and Young, Ramsey, and others. We wish simply to report a case of this unusual condition.

As is well known these tumors occur at any point along the spine, but are most frequently found at the spheno-occipital synchondroses and more rarely at the sacrococcygeal junction. They develop from cell rests, remnants of the chordo dorsalis which are found in about 2 per cent of human embryos in the intervertebral discs.

The first case of chordoma was described by Lushka (1857). In this year Virchow also described these tumors under the name of "Echondrosis Physaliphora" believing them to be cartilage which had undergone hydropic change. Mueller, however, first described the true nature of these growths. He called attention to the notochordal remnants in the intervertebral discs and suggested that these tumors developed from them. It remained for Ribbert (1894) to give the name "chordoma" to these growths and offer experimental proof of their origin.

In the case about to be reported, the cause of the patient's illness was not diagnosed for nearly 9 years, during which time he was treated for fistula in ano, perirectal abscess and recurrence of these conditions. The true nature of the condition was discovered when the tract was laid wide open and pieces of the gelatinous tissue which lined it were subjected to microscopic examination.

**CASE 4.** Mr A. L. S. aged 27 years was first seen by one of us January 17, 1923. His complaint was rectal trouble which had begun about 9 years ago. He first noticed a swelling near the anus which later was operated on February 9, 1925 and was considered a perirectal abscess. Several months later he was operated on for condylomatous tags. He continued to have discharging sinuses and a few days before being seen by us another abscess opened externally on the right buttock. This was still draining at the time of the examination. He complained also of frequent inclination to defecate without being able to empty the bowel completely and had the sensation as if there were a lump near the anal margin. There had been no discharge of blood from the rectum but mucus and pus were frequently passed. He had lost about 18 pounds in weight during his entire illness.

The patient's general physical examination was quite normal except for a moderate anemia and a leucocytosis of 12,500. X-ray examination of the chest and long bones and pelvis showed no metastases. On rectal examination the sphincter control was found somewhat weak. A discharging sinus was found in the right buttock. A probe passed inward toward the anal canal but did not enter it. There were several granular looking skin tags about the anus. On digital examination there was felt a great deal of scarring about the lower rectal wall with bands and irregular nodules. Diagnosis of some unusual type of fistula was made possibly due to tumor.

Operation: Church Home and Infirmary, January 19, 1928. ethylene gas anesthesia. The external opening on the right buttock was injected with a solution of methylene blue. This immediately came out of the anal canal in large quantities showing a complete fistula. The tract was divided on a grooved director and found to lead upward into the rectum to a point about 1.5 centimeters above the skin margin in the posterior midline. There were two or three lateral sinuses branching off from the main tract which burrowed upward a long distance into the pelvic fat. The entire fistula was lined with thick coarse granulation tissue and gelatinous material. It was laid wide open throughout its entire extent and thoroughly curetted. In order to do this it was necessary to divide part of the sphincter muscle in the posterior midline. Bleeding points were tied and the wound packed with five strips of iodoform gauze. The patient left the table in good condition. The fistula was an exceptionally deep and tortuous one and would probably take a long time to heal.

**Postoperative history.** For about 2 weeks following the operation the patient experienced considerable pain. The wound discharged copiously for about the same period. Gradually the pain and discharge diminished, the size of the wound reduced and the patient's general condition improved. He was given radium treatment to supplement

the obviously incomplete surgical removal of the disease. His sphincter control became better and he was discharged from the hospital in fairly satisfactory condition. When last heard from over a year after operation his wound had completely healed, he had gained weight, was working as usual and complained of nothing except some weakness of sphincter control.

**Gross pathology.** The tissue consists of several pieces of tissue varying in size from 3 centimeters to small scrapings. It showed small and large lobulated gelatinous translucent areas interspersed with bands of opaque connective tissue. Several hemorrhagic areas of various sizes are present in different regions.

**Microscopic examination.** The thick fibrous capsule so uniformly described about these tumors is absent because the tissue received was from curettings rather than an enucleation of the growth. There are however strands of fibrous tissue throughout the growth tending to divide it into pseudo alveoli. The cells are large oval to polygonal in shape with deep staining round and oval nuclei. Some of the syncytial masses contain several nuclei. The cytoplasm is pale staining and granular. Some of the cells are ballooned with masses of blue staining mucin, the so called physaliphore cells and others are vacuolated breaking up to form the characteristic foam cells. The cells are arranged in solid masses or in irregular strands. In general, the appearance of liver tissue, the interstitial tissue being filled with vacuoles or mucin. Throughout the tumor and especially along the strands of connective tissue is marked round cell infiltration.

Photomicrographs of tissue from each of these four rare tumors are presented.

## BIBLIOGRAPHY

1. ALBERT HENRY. *Surg Gynec & Obst* 1915, **xx**, 766-770.
2. ASHTON, T. J. *Diseases of Rectum*.
3. BALL, SIR CHARLES. *The Rectum* 1909.
4. BENSADRE, R. and RACHET, J. *Bull et mém Soc méd d hôp d Par* 1924 **xliiii** 1472.
5. CAPPELL, D. F. *J Path & Bacteriol*, 1928 **October**.
6. DANZEL, Arch. f. klin. Chir. 1874 **p** 442.
7. GANT, S. G. *Diseases of the Rectum and Anus* 1923.
8. HILL, T. C. *Manual of Proctology* 1926.
9. HUNT, V. C. *Ann Surg* 1921 **xxv** 236.
10. HUTTON, ANDREW J. and YOUNG, ARCHIBALD. *Chordoma*. *Surg Gynec. & Obst* 1929 **xliiii** 333.
11. LUSKA, Die Altersveränderung der Zwischenwirbelknorpel. *Arch f path Anat* 1856 **ix** 317.
12. LYNCH, J. M. *Diseases of the Rectum*.
13. MARGOT, R. *Proc Roy Soc Med Section on Surgery* 1921-22 **xv** 94.
14. MUELLER, H. *Ztschr f rat Med* 1858 **ii** 202.
15. FORT, H. *Tr Path Soc Lond*. 1880 **xxx** 307.
16. RAMSEY, THOMAS L. *Sacrococcygeal chordoblastoma*. *Arch Path & Lab Med* 1929 **February** 232.
17. SAPHIR, J. F. *Med J & Rec* 1923 **cxli** 144.
18. STEWART, MATTHEW J. *Malignant sacrococcygeal chordoma*. *J Path & Bacteriol* 1923 **p** 40.
19. TUTTLE, JAMES P. *Diseases of Rectum* 1907.
20. VOLFFER, JOHN A. *Surg Gynec & Obst* 1928 **xliii** 643.

## THE USE OF INTRAVENOUS GLUCOSE IN DIABETIC PATIENTS

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It is well known that in surgical cases the use of intravenous glucose following operation, and glucose or carbohydrate in some form the night preceding the operation, is a very valuable measure. This applies especially to cases in which the patient starts vomiting after the operation and can hold nothing on his stomach, not even water and through incessant vomiting, becomes partly dehydrated, developing a degree of alkalosis which in turn aggravates the vomiting, thus establishing a vicious circle. As the result of the administration of intravenous glucose solution, this vicious circle is broken, and the patient has an infinitely better chance of recovery.

While in the case of non-diabetic patients there is no doubt as to the value of the intravenous administration of glucose, in the case of diabetic patients, the following questions arise: "Can we safely give glucose to diabetic patients? Will we get the same result as in the non-diabetic cases?"

While a normal individual apparently has available an unlimited supply of endogenous

insulin, so that no matter how much carbohydrate he is given he can take care of it, the diabetic patient, on the other hand, has not enough endogenous insulin available. If the use of glucose in the case of a non-diabetic individual is a good physiological measure, it should be equally good in the case of a diabetic individual if in some way we can assist the patient to take care of the added glucose in the blood stream. In the pre-insulin era this was impossible, for any addition of glucose to the already increased sugar in the blood would have been an unsafe procedure. However, now that insulin is available and may be used as frequently as the need for it is indicated, the problem has taken on an entirely different aspect. We can supply the needed insulin to the body from without, and thus the diabetic individual may have the advantage of this, and the mortality of operations on diabetic patients may be lowered.

The method which I have used here in the Clinic has been the intravenous administration of 250 cubic centimeters of a 10 per cent solution of

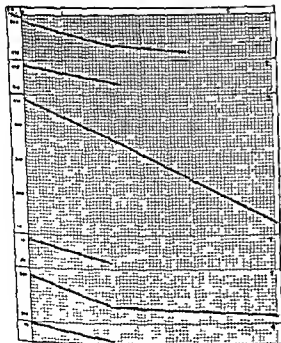


Chart 1

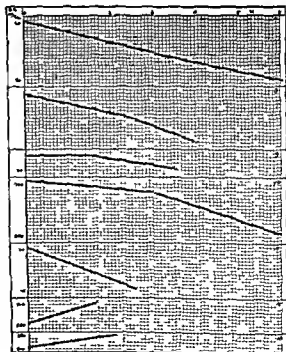


Chart 2



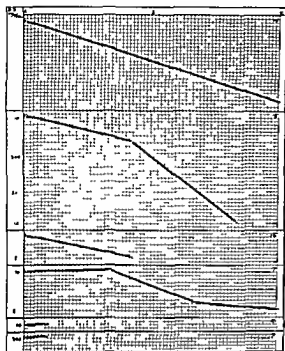


Chart 3

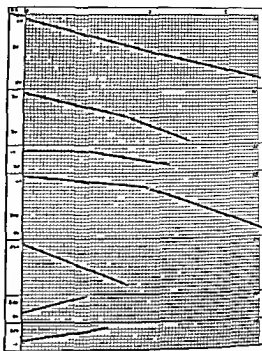


Chart 4

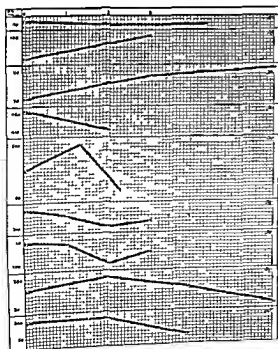


Chart 5

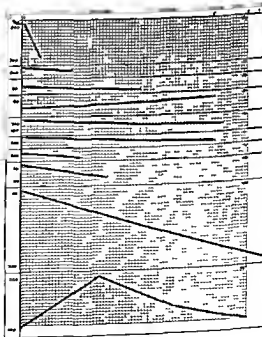


Chart 6

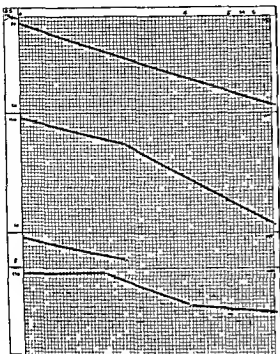


Chart 7

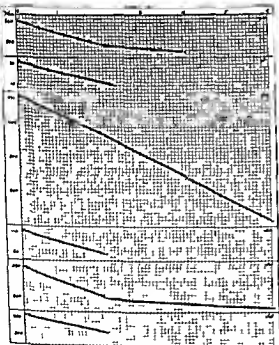


Chart 8

TABLE I—CHANGES IN BLOOD SUGAR AFTER THE INTRAVENOUS ADMINISTRATION OF GLUCOSE—FIFTY FOUR CASES

Case	Changes in blood sugar mgm. per hr		
	Fall	No change	Rise
1	22		
2	24		
3	60		
4	33		
5	10		
6	38		
7	28		
8	34		
9	10		
10	26		
11	47		
12			38
13			18
14	30		
15	58		
16	24		
17	18		
18		0	
19		0	
20	28		
21	34		
22	10		
23	26		
24	47		
25			38
26			20
27	18		
28			22
29			14
30	28		
31	28		
32	11		
33	10		
34	8		
35	14		
36	08		
37	6		
38	3		
39			5
40	4		
41	4		
42	0		
43	18		
44	22		
45			0.3
46	38		
47	50		
48	24		
49	16		
50	22		
51	28		
52	61		
53	33		
54	10		
55	28.7	8	0
56			25.3

Of a total of 54 cases, 44 or 81.5 per cent, showed a fall of blood sugar 3 or 3.3 per cent, showed no change, and 8, or 14.5 per cent, showed a rise of 11.54 mgm. The average fall of blood sugar (44 cases) or 81.5 per cent was 19.20 mgm per hour. The average rise of blood sugar (8 cases) or 14.5 per cent was 10.75 mgm per hour.

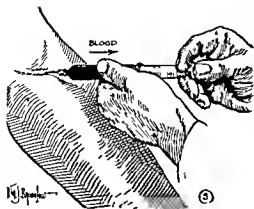


Fig 1 Withdrawal of specimen of blood before administration of glucose

glucose to which from 20 to 50 units of insulin has been added, the amount of insulin depending on the severity of the diabetes and the height of blood sugar at the time. This procedure can be repeated two or even three times a day, as the need for it is indicated.

When glucose is given intravenously in the case of a diabetic patient, the glucose apparatus should be filled to the tip with the warm solution. Cooling should be allowed for during the process, so that the solution in the bottle should be quite warm. A specimen of blood should then be secured through a venepuncture for blood sugar determination (Fig 1). While the needle is still in the vein, the end of the needle next to the syringe should be grasped with a hemostat so as not to dislodge the needle from the vein. The syringe

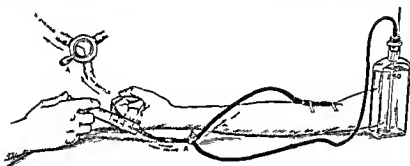


Fig 2 Apparatus for intravenous administration of glucose

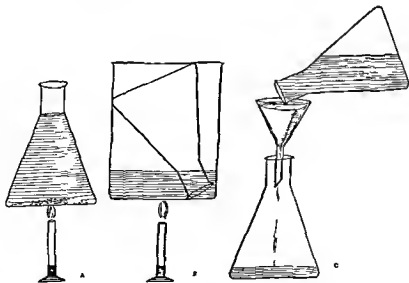


Fig 3 Method of sterilizing glucose solution and container

filled with blood is then disconnected from the needle, and the adapter of the glucose outfit inserted into the needle in the vein. In this manner blood is secured and glucose administered through one venepuncture. A practical outfit for the intravenous administration of glucose is illustrated in Figure 2. This consists of an ordinary bottle with a capacity of 250 cubic centimeters (8 ounces), rubber tubing, a three way stopcock, and a 10 cubic centimeter Luer glass syringe. By one turn of the stopcock the syringe is filled, by another turn of the stopcock its contents is emptied into the blood stream, and this procedure is repeated until all the solution is used up.

The preparation of the glucose solution is simple. Twenty five grams (1 ounce) of chemically pure glucose is dissolved in an Erlenmeyer flask in enough freshly distilled water to make 250 cubic centimeters. This solution is brought to the boiling point (Fig 3, A). The neck of another Erlenmeyer flask is sterilized in a beaker of water (Fig 3, B) and the dissolved glucose is filtered from flask A to flask B (Fig 3, C) the contents of which is simply brought to the boiling point, when the solution will be sterile and ready for use.

It may be difficult to make the venepuncture. Thus if the needle is quite sharp, as it should be, it may perforate both walls of the vein. Figure 4 illustrates such a mishap and offers a remedy. Simply pull slowly on the syringe and plunger at the same time, and as soon as the needle has entered the vein, blood will appear in the syringe.

When insulin is added to the glucose, the diabetic patient should theoretically be protected from a rise of blood sugar. That this is actually true in practically all instances can be gleaned from Charts 1 to 8, in which I have drawn the blood sugar curves following the intravenous administration of glucose plus insulin in a series of 54 cases of diabetes. These demonstrate clearly that there need be no fear of endangering the status of a diabetic patient by the administration of glucose if the blood sugar is checked by subsequent examinations. Even though the blood sugar should rise, this can be easily controlled by the administration of additional insulin either hypodermically or intravenously.

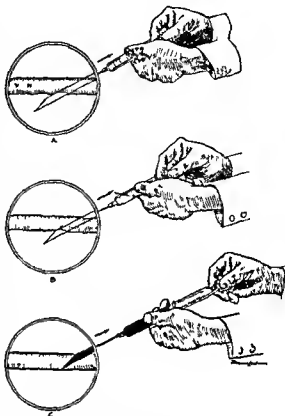


Fig 4 A remedy in case both walls of the vein have been penetrated through venepuncture

This series of charts has been drawn from data secured in cases of diabetes in which an operation has been performed, and in cases of diabetic coma in which also the use of intravenous glucose is a great aid in overcoming the acidosis and increasing the excretion of acetone bodies through the urine. Furthermore the practically glycogen free liver as well as the heart muscle is thus restocked with glycogen.

In Table I, the data illustrated by the charts are summarized. From these data, I believe that we can feel quite free, in cases of diabetes wherever this is indicated to use glucose intravenously to the great advantage of the patient.

# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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Chief of Editorial Staff

APRIL 1930

### THREE SCORE AND TEN

THE brain of man is a visual brain. The mind of man was built up coincidentally with the eye and it is this fact not the mechanics of the eye that has made intellectual progress possible. In the lower vertebrates an expanded olfactory ganglion was the forerunner of the cerebrum and the sense of smell not only controlled their behavior, but it remains in the lower animals the only special sense which is not relayed through intermediate ganglions. The great expansion of the cerebrum in man however completely overthrew the dominance of the olfactory sense giving control to vision, and establishing direct relationship with consciousness thereby governing behavior.

The microscope introduced by the Janssen brothers, in 1590, was the most significant scientific contribution of all time and was destined to change the history of mankind, because it extended vision into the more minute, and thus made possible comprehension of the vast realm of micro organisms.

My professional advent was early in the development of Pasteur's germ theory of

disease and Lister's application of it to surgery. As a result of that epochal work through which came the elimination of contagious and infectious diseases, the average lifetime of man has increased 20 years. But we have not been so successful as had been expected in carrying the individual from middle age to the Biblical age of three score and ten.

Why is it, that whereas the total number of persons who reach middle life has been enormously increased the relative percentage of those who reach three score and ten has not been correspondingly increased? There is no known normal length of human life. In the problem of life expectancy there are many factors to be considered of which heredity is the most important. Exposure to disease producing influences, the character of employment of profession, and hazards of all sorts, all must be taken into account in attempting to establish an age probability.

We commonly think of hazards in nature as being physical but the emotional hazard must be taken into consideration as well. Generally speaking the medical profession is rated high for longevity but this is more true of the internist than of the surgeon. The statistics of the Royal Victoria Hospital of Manchester, England, showed that the death rate among surgeons after 50 years of age was more than three times that among physicians in the same age period.

However experience has shown that in the fifth decade especially if vitality is lowered for any reason life may terminate as a result of a relatively unimportant affection, such as a cardiorenal disturbance or a pulmonary disorder. We must now undertake to determine

the nature of those obscure metabolic changes which lie behind these too early fatalities

The investigations which are necessary to analyze the individual in his life processes lie in the colloidal field, beyond the microscope. With the microscope, particles  $1/10$  micron, approximately  $1/250,000$  inch, in diameter are visible, but the colloidal field includes particles between  $1/10$  micron and  $1/1,000$  micron, approximately  $1/25,000,000$  inch, in diameter. In this field, not the object itself but its shadow is seen, because the colloidal particle is larger than a ray of light and it reflects the light as though it were a mirror.

Below the colloidal field, in the division of size, lies the molecular field, and beyond that the atomic field. Because the atom is larger than the electromagnetic manifestation of the X ray, it has been separated into the electron and the proton, which lie in the experimental field.

Although the single colloid particle or molecule cannot be seen with the eye, because it is so minute, colloidal particles or molecules may become visible in the mass aided by staining properties.

Geraghty and Rowntree took advantage of this fact in the development of the phenol sulphonephthalein test of the function of the kidney, which not only had the greatest scientific value in demonstrating the permeability of the kidney to certain substances with a urea like filterability, but by timing the process of elimination gave an extraordinarily correct estimation of the function of the kidney. Rowntree and his associates in later experimentation with phenoltetrachlorophthalein demonstrated that the drug was always eliminated in the bile and perfected the best test known for function of the liver when jaundice is not present. And again phenoltetrachlorophthalein was used as the starting point in cholecystography, in that it was

shown that bile containing this dye was more opaque than normal bile. This research led to the recognition of similar opaque substances of even more valuable aid in eliciting diagnostic evidence of disease of the biliary tract through the X ray.

We have become so "eye minded" that it is difficult for us to appreciate that invisible colloidal and molecular particles are just as physical as though we could see them. After all, it is merely a question of size.

As surgeons we are interested in the metabolic processes in the preparation of elderly patients for operation. The advances made by biochemistry in securing better results in surgery, through rehabilitation of the patient, have had an equally profound influence in medicine and point the way to prolongation of life.

W J MAYO

## LUMINAL AND THE NEWER CONCEPT OF ANÆSTHESIA

THAT there is dissatisfaction with our present anæsthetics, as commonly employed, is shown by the number of new methods of inducing anæsthesia put forward in recent years both here and abroad. The most significant feature of the viewpoint prompting this movement is its indication of a changing conception of the function of an anæsthetic. One has now a right to expect that an anæsthetic shall do more than abolish pain during operation and give the necessary relaxation with the minimum risk. From an increasing regard for the needs of a surgical patient as an individual and not as a lesion or a disordered mechanism, there comes a sense of how greatly the patient's burden could be lifted if he could be promised that he would know nothing of what takes place from the time of going to sleep on the night before operation until the day following

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However experience has shown that in the fifth decade especially, if vitality is lowered for any reason life may terminate as a result of a relatively unimportant affection such as a cardiorenal disturbance or a pulmonary disorder. We must now undertake to determine

The dose of luminal varied from 12 to 30 grains given in one dose, as is now our routine. This plan has no place, of course, in patients who have much gastric retention or in those who are vomiting for any reason and in whom fluid by mouth is contra indicated. One should be cautious in the use of luminal in conjunction with spinal anæsthesia, for the combined effect may cause sufficient drop in blood pressure to be temporarily embarrassing. We have experienced this only once, moreover, a patient, uncertain of his balance and not able to co-operate thoroughly, might conceivably make a sudden movement and cause breaking of a needle. Patients entering the hospital are tested for individual idiosyncrasy by small doses of luminal. In a few cases there was a very transient skin rash as the only toxic manifestation. The economic saving to a patient who is not vomiting, excitable, suffering, or disturbing his neighbors is reflected by a lessened demand on nursing service.

We have found a wide field of usefulness

for this procedure. With a routine dose of 15 grams of luminal (for *non thyrotoxic* individuals) and nitrous oxide, occasionally supplemented by a few whiffs of ethylene during packing off, cholecystectomy and other procedures down to the hysterectomy level (where we ordinarily prefer "spinal") are readily accomplished. A moderate amount of abdominal exploration is entirely feasible. The radical breast amputation furnishes an excellent opportunity also. Certainly in the case of thyroid surgery the manifold advantages of the "luminal effect" are at their best. It is useful in the minor anal and rectal operations where one has been used to particularly deep anæsthesia.

But beyond all figures and an author's enthusiasm, the court of last resort is the feeling of a patient who has experienced this "semi anæsthesia" after previous operation under different methods. His enthusiasm for it makes even a casual visitor realize how nearly completely the dreads of a surgical patient can be removed. WILLARD BARTLETT



operation. An ideal anæsthetic would provide such an *oblivion* without complicating induction or adding to the risk and morbidity.

With this in mind, we have studied, during the last 9 years in over 1,100 selected cases, the two most widely known of the barbituric acid compounds, *veronal* and *luminal*. In agreement with experimental and clinical work of other recent investigators, we believe that by a combination of anæsthetic agents one can stay within the limits of safety of each and exploit the good properties of several. We do not attempt to produce full surgical anæsthesia, therefore, with luminal (our preferred drug), but use it in doses sufficient to produce a narcosis, a "semi-anæsthesia." We prefer luminal because (1) there is a voluminous clinical and experimental literature, without a single authenticated death from the use of luminal alone (though single doses of 50 grains have been reported twice), (2) it causes less nausea and loss of equilibrium than does veronal, (3) veronal has a bad reputation, however undeservedly, as a suicidal agent, especially among the laity. The final surgical anæsthesia is induced by nitrous oxide or ethylene (in much lower concentrations than can be used otherwise), and is therefore *instantly controllable*, or by local or spinal anæsthetic.

We have learned to anticipate the desired "luminal effect."

Three hours before operation the patient is given the drug in one dose and it takes effect in about 1 hour. He comes to the operating room without interest in his surroundings, often asleep but can be roused to answer questions. The first needle prick of local infiltration or the first few whiffs of an inhalation anæsthetic are not noticed. Morphine is not used before operation and there is rarely vomiting or sweating during opera-

tion. By removing the mask during operation the patient can be roused to talk or swallow, if desired. After operation he lies quietly in any position in which he is placed sleeps normally, or is quite apathetic but can be roused to drink. The reflexes, importantly the cough and gag reflexes, are not interfered with. This effect lasts ordinarily from 12 to 24 hours—in one case as long as 56 hours. Sharp pain will rouse the patient, as it will from normal sleep, and for such pain we give morphine, but the aches, the vague general discomfort, and the sense of frightened confusion that are the common sequelæ of all surgical procedures do not disturb these patients. On the day after operation, they rarely recall anything of the events of the previous day—going to the operating room, inhalation of anæsthesia, postoperative dressings, physician's examinations or even the faces of the special nurses who came on duty just before operation.

The last 164 cases in which this method was used have been analyzed and reported in detail. Of those who had luminal in one dose, it is interesting to note that 74 per cent of the thyroidectomies (the great majority being toxic) and 45 per cent of other major operations were accomplished with nitrous oxide alone with an ease hitherto undreamed of for this gas, 70 per cent of those having luminal in one dose did not vomit during or after operation, and 53 per cent did not require morphine in the first 24 hours after operation. There were no significant changes in blood pressure pulse or respiration. Except in those patients who were put on a *peritonitis* regimen as a precaution after operation hypodermoclysis was rarely used. The absence of nausea allowing the patients to drink freely. Sweating was rarely seen and we have never known such freedom from postoperative respiratory complications.



JOHN MORGAN  
1735-1789

# MASTER SURGEONS OF AMERICA

## JOHN MORGAN

**J**OHN MORGAN, who was not a surgeon, was important in the history of American surgery because of his pioneer status as a medical educator and founder of our first medical school and because he was physician in chief and director general of the hospital in the Revolution, a position corresponding to that of the surgeon general of the Army at the present time.

He was born in Philadelphia in 1735, the son of well-to-do parents, Evan and Joanna (Biles) Morgan. He was first sent to school to Rev. Dr. Finley's Nottingham Academy where he received the classical training for which the place was famous, and then to the College of Philadelphia, where he graduated in the first class to be granted literary honors, that of 1757. During the last years of his college course, he took up the study of medicine under Dr. John Redman. With the medical education derived from this apprenticeship, he became a surgeon, as well as a lieutenant of the line, in the French and Indian War in 1758, being attached to Forbes' expedition against Fort Duquesne. In 1765 he spoke of having had four years of military experience but it is impossible to see how this could have been so. In 1760 he left the army and sailed to Europe to continue his studies in medicine. In London he worked under William Hunter for a year and then spent two years in Edinburgh, where he was given the M.D. in 1763. From Edinburgh he went to Paris and there spent a winter in the study of anatomy. Thereafter he made the grand tour, calling upon and being warmly received by Morgagni and Voltaire. His journal covering this tour has been published and it reveals the young man taking his sightseeing and art very seriously and systematically. He was made corresponding member of the Academy of Surgery of Paris, a Fellow of the Royal Society, licentiate of the College of Physicians of London and member of the College of Physicians of Edinburgh. During his residence abroad he planned with William Shippen the founding of a medical school in Philadelphia, and upon his return there in 1765 armed with a strong letter from the proprietor, Thomas Penn, he proposed the establishment of a medical school in connection with the College of Philadelphia (University of Pennsylvania). The idea was approved and he was elected professor of theory and practice of physic, and Shippen was given the professorship of anatomy and surgery. The new school prospered and it has always been one of the leading schools of America.

Before he left England and again in Philadelphia, Morgan wrote that he would attempt the practice of medicine without dispensing his own drugs or practicing surgery, and there is no evidence that he ever did either, except that he attended the wounded on the battle field. He brought from England an apothecary to whom he sent his prescriptions.

In October, 1775, Dr. Morgan was appointed director general and physician in chief to the hospital, in succession to Dr. Benjamin Church, who had been detected in correspondence with the enemy. Morgan at once repaired to Cambridge, where he assumed the duties which so nearly overwhelmed him for the next fifteen months. Morgan had trouble with Dr. Stringer, director of the Hospital of the Northern Department, with Dr. Shippen, director of the Hospital of the Flying Camp in New Jersey, and with the regimental surgeons and officers, who felt that he was negligent of their needs and opposed to their interests. Congress also, influenced by complaints, showed itself hostile to him and eventually, in January, 1777, it dismissed him and Dr. Stringer without trial, and a few months later it promoted Dr. Shippen to the position of director general. Dr. Morgan at once began to beseech Congress for vindication. This Congress granted in June, 1779, in a resolution which declared that he "did conduct himself ably and faithfully in the discharge of his office" but it did not reappoint him to the office. Meanwhile Morgan was joined by Benjamin Rush, James Tilton, and perhaps others, in making charges against Shippen. Shippen was brought to trial in 1780 and was honorably acquitted. Morgan's accusations against him were doubtless motivated in part by chagrin, while the writings of Rush and Tilton show them both to have been men of acrid humor and hearty dislikes. Such was the disorganization, poverty, lack of transportation, low state of discipline in the Army, such the jealousy between colonies and communities, such the lack of preparation for war and the ignorance and indiscipline of the people, such the meddlesomeness of Congress and its neglect of the Army, that it may be that nobody could have been more successful as director general of the hospital in 1776-7 than was Morgan. As a matter of fact, Washington's success with the Army of that time was little better. Nevertheless, Morgan's "Vindication of his Public Character," written by himself and published in Boston in 1777, does permit the inference that, despite the evils with which he had to bear or to contend, he might have accomplished more except for drawbacks due to his own personality. These faults were apparently two: first, an inability to delegate work, which was not wholly compensated for by the hardest of work on his own part, and second, a mistaken or too modest conception of his duties as director general. The individual regiments at first brought their own medical men, and Washington found the need at Cambridge to be for a general hospital service. Congress legislated for that, but not, as Morgan viewed the matter, for any regimental service, whereas the regiments and apparently the States, and possibly





Congress itself, expected him to make provision for all medical necessities. Had Morgan boldly taken this same view and regarded himself as the one responsible for all medical service, he might have had greater support from the regimental officers, line as well as medical, and so had greater success. As it was, he regarded himself as having to do only with "The Hospital" and not with the regiments, he was unable to furnish these with necessary supplies, the regimental surgeons thought him negligent of, and opposed to, their needs and they worked against him. From their enmity arose a large part of his troubles.

Another large part came from the promotions of Stringer and Shippen, due partly to politics, possibly in part to the machinations of the two, but possibly also in part to Morgan's too great concentration on the work in his immediate vicinity, with consequent inability to look after the service of distant forces in any effective manner.

As a young man, Morgan was admired and copied, he had his place among the intellectual elite of the city, he was sufficiently untrammelled by custom to be able to avoid surgery and the dispensing of drugs, things which all other American physicians did. He could even indulge in the then foppish peculiarity of carrying a silk umbrella.

After his military service he wrote nothing except his "Vindication" and he largely retired from the public gaze, although continuing to practice and to teach. He died at Philadelphia on October 15, 1789.

He was a learned man, a delightful personality possibly an excellent administrator, certainly a hard worker but his army service came at a time when success in it was all but impossible, when Washington himself was meeting with every kind of defeat and discouragement. But he is one of the great figures in American medical education. His published writings are (1) *De Puoplesi, sive Tentamen Medicum Inaugurale de Puris Confectione* Edinburgh 1763 55 pp (2) *Discourse upon the Institution of Medical Schools in America* Philadelphia, 1765 91 pp 12 mo (3) *A Recommendation of Inoculation, according to Baron Dimsdale's method* Boston, 1776 18 pp (4) *A Vindication of his Public Character in the Station of Director General of the Military Hospitals and Physician in Chief to the American Army, Anno 1776* Boston, 1777 158 pp (5) *The Journal of Dr John Morgan Lippincott, Philadelphia 1907* 259 pp

P M ASHBURN

#### REFERENCES

- 1 Retrospective Review Professor Morgan North American M & S J 182 iv 362
- 2 An Account of Dr John Morgan By Benjamin Rush M D Phila J M & Phys Sc 1820 i 439
- 3 John Morgan By W I Wilbert Am J Pharm 1904 Jan 1
- 4 Institution of the College of Physicians of Philadelphia By W I Ruschenberger M D Tr Coll Phys Centennial volume Philadelphia 1887
- 5 John Morgan Director General and Physician in Chief of the American Hospital 1775-1777 By James Evelyn Pilcher J Ass Mil Surg 1903 xii 401
- 6 John Morgan Father of Medical Education in North America By William Shaull Middleton M D Ann. Med Hist 19 7 ix 13

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN M.D. F.A.C.S. OMAHA, NEBRASKA

### THE WORKS OF DANIEL SENNERT

DANIEL SENNERT was a contemporary of Cæsar Magatus and one of his most severe critics and bitter opponents. He belonged to the school which admitted no change from the ideas of the ancients and bitterly opposed anything which had to do with progress beyond the established routine. A believer in the supernatural and in alchemy, recommending to his colleagues and students the study and employment of astrology, and imbued with a belief in the origination of disease in witchcraft and magic, he could hardly be expected to be an unbiased observer and practitioner who would accept new methods or even consent to try them. His first impulse would be to condemn them heartily.

Sennert was a German who received the best in education that his country afforded but went no farther than Switzerland to obtain outside information. Consequently, he would naturally be more or less narrow in his beliefs and viewpoints. He was born in Breslau in 1572. His education he obtained in Wittenberg, Leipzig, Jena, Frankfurt on the Oder, and finally in the University of Basle. Then he returned home and began to practice and teach. He was appointed professor of medicine and served six terms as Rector of the university. It followed from his preeminence in medical and university affairs that he was appointed physician in ordinary to the Elector Johann Georg of Saxony. He died of the pestilence in 1637.

Sennert never wrote a book devoted to surgery alone. It is doubtful whether he ever practiced it actively. He was nevertheless well grounded in surgical theory and knew not only the beliefs and practices of the ancient authors but also those of his contemporaries and those who had shortly gone before. He shows that he was acquainted with the works of Dalla Croce and Fabricius of Acquapendente in Italy, Pare in France, Fabricius Hildanus in Germany, and Pieter Paw in Holland. In other words the authors of the surgical classics of the time. These he knew as a bystander on the sidelines as it were, but with his aloofness he nevertheless could not resist the opportunity to mix into the most active surgical squabble of the period and in fact became one of the principals in it. In 1612 he published his *Principles of Medicine and concerning*

*the origin of the Living Principles in Brutes*. This went through several editions and the second section of its fifth book is devoted to the type of surgery noted above.

Later in 1616, Cæsar Magatus published his work on wounds which aroused Sennert's antagonism and in his *Opera Omnia* published in three great folio volumes at Leyden in 1650 one finds the fifth book beginning with the fourth part discussing the question of wounds. After describing the various types of wounds their complications and the primary treatment of uncomplicated as well as complicated wounds of various types to which he devotes eight chapters Sennert finally comes to grips with Magatus on his new method of treatment of wounds with infrequent dressings. He heads the chapter "A judicial inquiry concerning the method of curing wounds of Cæsar Magatus and Ludovic Septalius," and concludes the first paragraph after stating that Magatus had brought out a new treatment which differed from that of the ancients by saying "Ludovic Septalius in his eighth book of medical considerations praises commands and defends Cæsar Magatus and thinks he deserves praise both for advancing the study of the art of medicine and for freeing the sick from a disagreeable cure. And I do not think that I am injuring the public welfare if I being of a different opinion, propose to discuss that opinion in this place. The arguments that Sennert advanced to prove Magatus wrong are long and wordy but always can be boiled down to one—that the ancients never treated wounds the Magatus way and their patients did fairly well. Hence why change? Magatus could not resist an answer but could not make it over his own name for he was a cleric and mundane quarrels were not for him. So he published his answer as if written by his brother Jean Baptiste and reiterated all his arguments against frequent dressings and the use of tents and added a few new ones. He neglected to set down any definite rules when dressings should be changed.

The argument augmented interest in wound treatment if it did nothing else and whenever interest is aroused in a medical or surgical subject more efficient therapy follows. So Sennert, though primarily mostly interested in internal medicine through his contentiousness accomplished much for surgery by bringing the subject of wound treatment prominently before the profession.





*Vin Meditymæ medullam nōsse \* SENNERTVM vide  
Ora sic tulit, parem qui vix habet laude ingentē*  
CAR. SPONIUS D. M.

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## BONE CHANGES IN HYPERPARATHYROIDISM<sup>1</sup>

EDWARD L. COMPERT, M.D., CHICAGO  
From the Department of Surgery, University of Chicago

**E**NLARGEMENT of the parathyroid glands in certain diseases of the skeleton such as rickets, osteomalacia and osteitis fibrosa, were noted at necropsy by careful observers more than 20 years ago. Erdheim (10), in 1907 expressed the belief and offered experimental evidence to support his theory, that these instances of hypertrophy were an attempt on the part of the organism to compensate for the loss of calcium and thus a result rather than a cause of the disease.

While studying a case of osteitis fibrosa cystica, Schlagenhaufen in 1915 recommended the removal of double palpable tumors of the parathyroid glands. Maresch one of his associates concurred in this opinion but J. Bauer, the surgeon who was responsible for the case, rejected the suggestion as too radical and dangerous a procedure. Mandl, however was possessed of a more adventurous spirit. In 1925 he gave Erdheim's theory a clinical test. Four parathyroid glands taken from the moribund victim of an accident were successfully transplanted to the abdominal wall of a man aged 38 years with generalized osteitis fibrosa but the bone disease became definitely worse following the transplantation. Mandl then decided that the previously mentioned hypertrophy of the parathyroid glands in similar skeletal conditions might be a cause and not a result of the bone changes. In an exploratory operation he found a tumor mass behind the left lobe of the thyroid gland and

removed it and at the same time he removed the parathyroid glands which had been transplanted to the abdomen. The tumor proved to be an adenoma of a parathyroid gland and following its removal there was steady improvement in the condition of the patient.

Since the report of Mandl's case parathyroid tumors have been removed from several other patients suffering from similar skeletal diseases. The similarity between the symptoms and observations in some of these cases especially that reported by Barr, Bulger and Dixon at St. Louis, and that of Wilder at the Mayo Clinic and the case which we shall report here led us to make a diagnosis of hyperparathyroidism.

Miss I. J. aged 50 years came to the University of Chicago Clinics in May 1929 complaining of pains in the bones of the legs particularly in the feet, bowing of both legs and general weakness. Although she had noted the bowing for only 2½ years the pains and weakness had been present for 3 to 5 years. The most recent development had been pain in the left hip. The weakness was so marked that she had fallen many times and on such occasions she could not regain her feet without assistance.

In spite of the fact that she had been breast fed as an infant the patient had suffered from infancy and until she was 3 or 4 years of age with an almost constant diarrhoea. She was never given cod liver oil and after she was weaned she had refused to drink milk. She first walked when 3 years of age. Dental caries developed early and while still a young woman all of her teeth were extracted. While she was never strong and never seemed to feel well the only definite illnesses which she could recall were rheumatic fever

<sup>1</sup>This work has been conducted under a grant from the Dr. Glas Smith Foundation for Medical Research of the University of Chicago.

## REVIEWS OF NEW BOOKS

In presenting the third edition of a two volume work on pediatric surgery, Kelley aptly states that "there should be children's surgeons as well as children's physicians or if one objects to cutting up surgery into little pieces" as Timothy Holmes says, it should at least be required that the surgeon extend his knowledge to *pediatrics*. The author understands the psychology of the child and beautifully expresses the relationship between physician and little patient. On the whole the work is well arranged and presented but is a work for general rather than specific reference.

In the consideration of general subjects in the first chapter various laboratory examinations are discussed but nothing is said of blood chemistry and the importance of stereoroentgenography. The section on postoperative care and on blood grouping and the various methods of transfusion in relation to hemorrhage and its control is very good.

The author in discussing the surgical treatment of hyperthyroidism makes the statement that "thyroidectomy should generally be preceded three or four months by ligation of the superior thyroid arteries one at a time some days or a week apart. Severe reaction may be looked for after each of these procedures." This advice since the introduction of iodine premedication by Plummer may be strongly contested. Multiphase operations are being abandoned even by such vigorous exponents as Lahey and Crile.

In the discussion of rickets one can hardly accept the statement that there is a "predisposition to general convulsions upon the slightest provocation, and further that 'vitamin A' the curative factor. Unfortunately the rôle of antirachitic vitamin D and the use of the irradiated sterols is omitted. The section on infantile scorbutus makes no mention of ascorbic vitamin C.

The treatment of burns is excellently written emphasis being placed on the tannic acid method and on the importance of the extension position in healing with early skin grafting.

Early surgical interference in acute osteomyelitis and later sequestrectomy are correctly urged. In the discussion of tuberculosis of bones and joints the author aptly states that in local treatment there is to be no resort to any operative measures unless all other means have been exhausted and then there is not to be in the case of any growing child an operation which mutilates or which destroys the epiphyseal lines of growth. Secondary infection must be avoided. Rest is the most im-

portant of all agencies for local treatment and all other means sink into such minor positions as to be almost negligible when compared with rest.

The sections dealing with hydrocephalus and intracranial birth hemorrhages are excellent. A very complete discussion of intubation in laryngeal diphtheria appears in volume II.

The omission of bronchiectasis from the section on surgery of the thorax is regrettable. Its importance in relation to swallowed foreign bodies per tussis and other respiratory infections should have been emphasized. Of 32 operative cases listed by Lelienthal in his text 17 patients were 10 years of age or younger.

In the treatment of peritonitis in general the author advises emptying the bowels by the use of calomel and salines. "Pain and tenderness can be greatly relieved by smearing the abdomen with extract belladonna one drachm to glycerina one ounce under oil silk." Such statements are reminiscent of the medicine of a long past day. The repeated reference throughout this text to the use of calomel and the salines in the acute infections can hardly be accepted by the reviewer who has never had occasion at any time in his practice to employ these drugs.

Anomalies of the bile passages which are not infrequently seen in the early jaundice and death of infants are not mentioned nor is there a section on the liver or pancreas.

As a text devoted to the general surgery of children the work is commended to the profession.

I MICHAEL EVERT

THE entire subject of gynecology is presented by Kelley in a relatively complete 1000 page volume. This book is well organized and beautifully illustrated. The newer diagnostic aids the tubal patency test hypodermic pneumoperitoneum etc and recent work on internal secretion are well presented.

The recent advances in gynecology, adenomyoma, radium therapy, diathermy, uterine structure and electric cautery are discussed.

Kelly's own work comprises the larger portion in this volume. He has selected as collaborators such men as Ward who beautifully describes plastic surgery.

Burnham's chapter on radium in carcinoma of the uterus merits special note. This volume deserves a place in the library of everyone who is interested in gynecology or pelvic surgery.

EUGENE A. EDWARDS

TABLE III—METABOLISM EXPERIMENT  
JULY 1 TO JULY 6\*

	Daily ave ages				
	Intake	Output		Total	Balance
		Urine	Feces		
Calcium	Gm 0.303	Gm 0.058	Gm 0.369	Gm 0.427	Gm -0.124
Phosphorus	0.794	0.450	0.375	0.825	-0.041
Nitrogen	8.51	5.760	1.66	7.42	+1.090

\*The diet during this period was held constant as near as possible to that in the previous experiment as possible. Aliquot portions (2/10) of all food were set aside, dried, and thoroughly mixed for analyses. Indigocarmine was used to mark the feces of the period. We are indebted to Dr. Calber Mac Coons for these analyses.

hyperirritable and hypercritical anxious moving restlessly in bed and complaining of tingling fingers and numbness of the hands. No definite Chvostek sign could be elicited but the tendon reflexes were all exaggerated. On the following morning as the serum calcium was found to be at what is usually considered to be a tetany level 6.97 milligrams for each 100 cubic centimeters of serum the administration of calcium lactate (2 grams three times daily) was begun. The restlessness quickly became less marked and the serum calcium began to rise to higher values. The serum phosphorus rose to normal values immediately after operation (Table I).

A metabolic balance run for the 6 day period July 1 to July 6 revealed a decided change in the mode of excretion of calcium (Table III). Before operation nearly 65 per cent of the calcium had been eliminated by way of the kidneys while the renal fraction after operation was reduced to about 11 per cent of the total the fecal fraction being correspondingly greater. The negative calcium balance of this period may be accounted for in part by the fact that contrary to orders that all intake be limited to the diet and distilled water the patient was given mineral oil for the first 3 days of the experiment. Gross particles of food and much oil were noted in the feces and this fact suggests that absorption of food including calcium was somewhat interfered with. A further and probably more important source of error is the fact that until 24 hours before the beginning of the experiment the patient had been receiving 6 grams of calcium lactate daily. While an indigocarmine marker was used it is possible that the first sample of feces contained some of the calcium given as medicine and not previously expelled. The low calcium content of the urine is ample evidence that the calcium in the blood and tissues was being retained. The diet in this metabolic period was identical with that used in the pre operative metabolic period June 3 to June 9 both being weighed diets of pre determined composition.

The patient returned to the clinic on August 21 stating that she was much stronger and was having less pain although following a fall she had noticed some pain in the left thigh. The observations at the

TABLE IV

Date	Blood serum				Product of Ca & P
	Calcium	Phosphorus	CO <sub>2</sub> Content	pH	
1929	Mg per cent	Mg per cent	Vol per cent		
Aug 19	11.11	3.64	61.9	7.63	40.4
Aug 20	Lost	3.904	66.4	7.57	
Aug 21	Lost	4.35		7.46	
Aug 26	10.57	4.212	65.4		44.5
Aug 28	11.05	3.8	68.3	7.51	42.0

general physical examination were essentially like those at the previous admission with the additional notation that the patient seemed to be more alert mentally reflexes were more brisk and she was generally more active than at the time of the first admission. The blood count was higher 5 100 000 erythrocytes and 80 per cent hemoglobin (Dare) and the basal metabolic rate was plus 1.

The appearance of the bones roentgenologically showed no change that could be detected at this admission which was less than 2 months after the operation. The serum calcium while not so high as when she first came to the clinic was at the upper limits of normal while the serum phosphorus during the admission was also a good normal ranging from 3.6 to 4.3 milligrams (Table IV).

On November 12 1929 the patient stated that she still had some pain in both thighs after standing for several hours but she declared that her strength was good and that in contrast to her previous lassitude it was difficult for her to reconcile herself to a daily rest period. She had gained 7 kilograms in weight since leaving the hospital following the operation. Reflexes at this visit were active. Serum calcium was 10.22 milligrams and serum phosphorus 4.21 milligrams. Calcium excretion in the urine for a 24 hour period with patient on her routine diet was 206.57 milligrams. This marked increase in urinary calcium output suggests a return toward a negative calcium balance but is not above the upper limit of normal. The general tone of the muscles was obviously much better than before operation but no change in the degree of skeletal deformity could be determined.

An X-ray examination on December 12 1929 showed no change in the calcium content of the bones. The patient was given vosterol (irradiated ergosterol) with instructions to take 5 drops three times each day.

She was seen again in the clinic on January 3 1930 and was feeling exceedingly well at that time and stated that she was stronger than she had been in more than 10 years. Prior to the removal of the parathyroid tumor she had been unable to remain on her feet for more than a very short time because of weakness. For more than 3 years before coming into this clinic she had been so weak that she often fell down apparently from the fact that her knees

TABLE I—ANALYSIS

Date	In Intestine			Total	Excretion
	Calcium Mg per cent	Phosphorus Mg per cent	CO <sub>2</sub> % per cent		
May 28	22.55	3.81	64.2	7.46	35.6
June 6	22.40	3.43	64.0	7.34	30.5
June 10	22.37	3.72	64.2	7.57	45.2
June 15	22.94	3.63	63.7	7.53	35.0
June 24 operation					
June 25	9.30	3.54	64.8	7.43	26.1
June 26	8.23	3.16	62.5	7.40	41.0
June 27	6.97	2.91	61.3	7.25	34.3
	Symptom of tetany				
June 27					
July 1	6.98	3.76	63.4	7.47	49.1
July 7	8.26	4.76	66.9		39.4
July 9	8.60	4.93		7.45	47.8

Calcium lactate 6 grams daily given June 27 to 30

TABLE II—METABOLISM EXPERIMENT,  
JUNE 3 TO JUNE 9 1929\*

	Daily averages				
	Intake	Output		Total	Balance
		Urine	Feces		
Calcium	Gm 0.702	Gm 0.371	Gm 0.108	Gm 0.479	Gm -0.225
Phosphorus	0.700	0.405	0.217	0.705	-0.01
Nitrogen	10.020	8.69	0.830	9.520	+1.4

\*The diet during this period was beefsteak, eggs, 1 portion of all food were set aside, dried, and thoroughly mixed. In the water was used from the first 24 hours of the period. We are indebted to Dr. Call Mac Connors for these analyses.

pressure 134/90 and the basal metabolic rate was plus 4. The erythrocytes numbered 4,000,000.

Röntgenograms revealed osteoporosis of the calvaria, osteoporosis and bowing of the femora and the same rarefaction of the pelvic bones and the lumbar vertebrae with sinking in of and male-like pelvis (Figs 3, 4, 5 and 6). Particularly noticeable was the thinness of the cortices of the shafts of the long bones. No sign of bone cyst or tumor was present.

Serum calcium was slightly elevated assuming 9 milligrams to 11 milligrams for each 100 cubic centimeters of serum to be the normal range while the serum phosphorus was lower than normal (Table I). Metabolic studies from June 3 to June 9 revealed a negative calcium balance and showed the excretion of an abnormally large proportion of the total calcium output by way of the kidneys (Table II).

A diagnosis of hyperparathyroidism was then made on the basis of the syndrome consisting of pain and bowing in the weight-bearing extremities, osteoporosis of the bones of the skeleton, progressive muscular weakness, elevated serum calcium and lowered serum phosphorus, a palpable nodule in the lower pole of the right lobe of the thyroid gland and a negative calcium balance. Since it was thought that the nodule in the right lobe of the thyroid gland was a parathyroid tumor, exploration for the tumor was advised.

The operation was performed by Dr. D. B. McMaster on June 24, 1929. The right lobe of the thyroid gland was found to be about double the normal size and there was a nodular enlargement in the body of the lower pole. This nodule when excised proved to be a thyroid adenoma and not a parathyroid. The surfaces of the upper and lower poles were searched for enlarged parathyroids and none was found. The left thyroid lobe was about normal in size and a nodule projected from the posterior inferior portion. This had a pedicle containing blood vessels. It measured about 1 by 1½ centimeters and was removed. A small mass near the upper pole considered to be a normal parathyroid was also removed.

The postoperative course was normal until June 26, 27 days after the operation, when the patient was

at the age of 9 and typhoid fever at the age of 18 years. Cardiac weakness with decompensation had caused dyspnea on exertion and some palpitation and this dated back to the attack of rheumatic fever.

The examination revealed a fairly well developed and fairly well nourished woman who did not look as old as her stated age (Figs 1 and 2). One was struck by the lack of tissue turgor for her skin, the subcutaneous tissues and the muscles themselves seemed to hang limply and in folds, giving the impression of extreme hypotonicity. All reflexes were present and equal but very sluggish.

The cardiac area was moderately increased in size and a loud systolic murmur was heard precordially and in the axillary line. A spherical nodule 2 centimeters in diameter could be palpated in the lower pole of the right lobe of the thyroid gland. Skeletal deformity was noted as follows: a marked kyphosis of the thoracic spine, slight thickening of both femora and some thickening and slight inward bowing of both tibiae and fibulae.

In walking there was just the slightest tendency to waddle and genu valgum was noted. This knock-knee deformity was not at all obvious when the patient was lying down but increased upon standing. In addition there was eversion of the feet and this became so marked after standing for a few minutes that the medial malleoli were less than an inch from the floor and the pes planus which was barely noticeable when she would first stand up became quite marked.

The body weight was 54.6 kilograms and height was 169 centimeters. The pulse rate was 75 per minute. The temperature was normal, the blood

logical diagnosis was benign adenoma of the parathyroid gland

*Procedure in serving calcium balance diet* The following diet was planned and the procedure in serving it was supervised by Miss Florence Smith in charge of the dietetic service of the hospital: protein 40 grams per kilogram body weight, fat 8. grams per kilogram body weight, carbohydrate 156 grams per kilogram body weight, calories 1556 (basal plus 15 per cent). Estimated calcium content 0.300 grams.

These constant diets were served on 6 consecutive days, breakfast on the first morning being served after indigocarmine was given and after venous puncture. All dishes in which food was served and silver used on tray were washed, dried and then rinsed in distilled water. Dishes in which hot food was served were placed in food truck to warm. All foods served on trays were weighed on balance scales and placed in dishes in which they were to be served, then one tenth that amount weighed for laboratory sample. Chemically clean beakers with covers were secured from the laboratory each morning and labelled with the patient's name, room number and date on both beaker and cover. The total day's allowance of butter was weighed first. One tenth of the total was placed in a beaker for analysis and allowed to stand in hot water until the butter melted, then the beaker was tilted and tured until the butter was well distributed on the walls of the containers. This procedure prevents food sticking and it is more easily removed from the container after drying. The day's allowance of bread, sugar, fruits and cereal for breakfast was weighed and one tenth portion of each food was placed in the beaker. All cooked foods were weighed hot and dishes in which they were to be served were placed in a food truck to maintain constant temperature. All food was cooked with distilled water. The eggs served were cooked in the shell, removed from the shell with a spoon which had been rinsed in distilled water and then weighed in the cup in which they were served. On the sixth day raw eggs were beaten in a bowl which had been rinsed in distilled water and an amount equal to one tenth the total weight of all eggs served was placed in the beaker containing the food aliquots for analysis.

On the fourth day of the second balance study period the patient was given approximately 34 glass of orangeade by error of the nourishment nurse. To minimize the error 15 grams of orangeade were added to the laboratory specimen on the sixth day. On the next day the patient was given carmine in the morning before the regular diet was resumed.

*Methods of chemical analysis* Food composites collected as described were left on a steam bath until practically dry, then removed to an electric oven at 80 degrees C. further dried to constant weight and then ground and mixed for analyses.

The faeces without transferring were covered with acidified alcohol and dried in the same manner as the food. All collections for the period were composited and ground for analyses.



Fig 3 The calvaria showing osteoporosis May 28 1929

Urine was collected into bottles containing toluol. One fifth of the total excretions for each 24 hours were combined and preserved with toluol and strong hydrochloric acid until analyzed.

Analyses for calcium were carried out according to the McCrudden method, the hydrogen ion concentration being adjusted with sodium acetate as described by Shohl. The precipitated calcium oxalate was collected on a Gooch crucible, ignited and weighed as calcium monoxide. The determinations were made on triplicate samples of food and faeces after they had been ashed in an electric muffle furnace and the ash dissolved in hydrochloric acid. The acidified filtered urine was evaporated and ashed and dissolved in hydrochloric acid.

The procedure used for phosphorus analyses involved moist oxidation with sulphuric and nitric acids according to Neumann and then double precipitation first as ammonium phosphomolybdate finally as magnesium ammonium phosphate following the McCandless-Burton technique. The last precipitate was collected on a Gooch crucible, ignited and weighed as magnesium pyrophosphate.

For total nitrogen determinations the Arnold-Gunning (21) modification of the macro-Kjeldahl procedure was used.

The calcium in the blood serum was determined by the Clark and Collip modification of the Tisdall and Kramer method. Phosphorus in the blood serum was determined by a slight modification of Fiske and Subbarow. Carbon dioxide content was determined by the Van Slyke method and the hydrogen ion concentration was estimated by the colorimetric method as described by Hastings and Sendroy; the Hastings bichlorimeter being used.

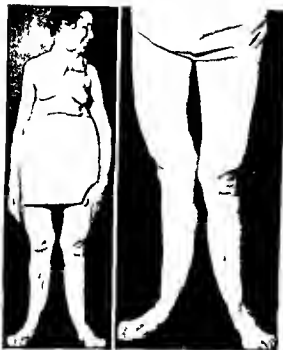


Fig 1 (left) The patient. There is obvious loss of tissue turgor and muscle tone. (Before operation.)

Fig 2 The lower extremities. Note the lateral curvature of the femurs, the genu valgum, the medial curvature of the bones of the legs, the eversion of the feet, and the marked flattening of the plantar arches of the feet.

simply gave way under her and she would not be able to regain her feet unassisted. She estimates that these falls occurred on the average of about two times each week. Since the operation 5 months ago she has fallen only one time and that was soon after leaving the hospital and was occasioned by stumbling. The pain in her feet which had almost completely incapacitated her for any kind of work for 2 or 3 years prior to her admission to this hospital has not been present since leaving here nearly 5 months ago. She does have some pain in the distal third of the tibia which comes on when she has been on her feet for an hour or longer but this does not interfere with her daily routine. Serum calcium at this visit was 10.92 milligrams and phosphorus was 4.82 milligrams for each 100 cubic centimeters of serum. These figures are well within the range of normal.

The last visit to the clinic was on March 10, 1930. Some aching of the tibiae had persisted but her strength was good. Serum calcium was 12.5 milligrams and phosphorus 5.712 milligrams for each 100 cubic centimeters of serum.

Throughout the course of these studies the hydrogen ion concentration and carbon dioxide content of the blood serum remained fairly constant although both were slightly higher than the accepted normal (Tables I and IV).

Pathological studies were made of the tissues removed at operation. The three specimens consisted of a wedge shaped mass of nodular thyroid tissue 2 centimeters in diameter from the lower pole of the right thyroid gland, a small nodule from the upper pole of the left gland and the tumor.

The wedge shaped mass of nodular thyroid tissue was not particularly interesting. Microscopic studies showed that except for the relatively large number of colloid containing vesicles in a few of which the lining epithelium was slightly flattened this section did not vary greatly from normal (Fig 7). The lining epithelium was smooth and regular and no portion of the section seemed to consist of an actively secreting gland. There were several areas of dense lymphocytic infiltration.

The second specimen which proved to be a normal parathyroid gland was a firm, solid, pinkish nodule measuring 2 by 4 millimeters with a delicate connective tissue capsule. The section stained with hematoxylin and eosin was seen to be composed almost entirely of cells resembling epithelial cells with a connective tissue network which divided the cells into irregular strands (Figs 8 and 9). These epithelial cells were of two types. By far the most abundant were relatively small cells with large nuclei containing many dark staining granules. There were also a few groups of large cells with relatively clear cytoplasm which stained pink with the eosin. In the central portion of the section there was an occasional vesicle or acinus. Numerous fat cells were noted and the entire section was quite vascular.

The tumor mass removed from the vicinity of the lower pole of the left thyroid gland was a smooth, reddish brown, semi-elastic, meaty nodule 1 by 1 1/4 centimeters with a fibrous capsule and a definite vascular pedicle (Fig 10). Microscopic sections stained with hematoxylin and eosin revealed a compact cell structure composed of cells resembling epithelium cells with numerous acini or alveoli which were lined with cuboid or low columnar epithelium in a number of which colloid material was noted (Figs 11 and 12). There were numerous blood vessels and while the bulk of the gland was composed of the alveoli in some portions of the section particularly near the periphery the epithelial cells were arranged in strands with blood spaces and some connective tissue between. Nodular figures were found but the nuclei of most of the cells were filled with large dark staining granules. A very few of the large clear cells noted in the normal gland were seen. As in the case reported by Wilder, no foam cell or fat cells were present.

The structure of the tumor differed from that of the normal parathyroid gland in the presence of numerous acini, the compactness of the cellular elements, the absence of fat cells, the absence of any strand like or trabecular arrangement of the epithelial cells, the preponderance of deeply staining granular cells and the scarcity of the large cells with clear pink staining cytoplasm. The patho-

Erdheim and diagnosed hyperplasia. Strauch studied a tumor which was removed from the neck of a woman who died after a typical attack of puerperal osteomalacia. His diagnosis of hyperplasia was based upon the presence of all of the normal cell elements while, according to his belief only one type of cell is found in the true adenoma.

The tumor which was removed from our patient was almost entirely composed of the one type of large epithelial cell with hyperchromatic nuclei and the predominating characteristic was one of acini formation. No portion of the gland resembled normal parathyroid tissue. We feel justified, then from a pathological standpoint, in making a diagnosis of parathyroid adenoma. If this were a compensatory hyperplasia as Erdheim and others believe it is difficult to explain why another gland on the same side should be entirely normal. If we then assume that the changes in the calcium metabolism were due to increased parathyroid activity we must conclude that either this adenoma was producing an abnormal amount of parathyroid secretion, grossly normal parathyroid glands were hyperfunctioning, or that there was some undiscovered and abnormally active accessory parathyroid tissue. The presence of a pathologically similar tumor in a rapidly growing series of reported cases lends weight to the first hypothesis.

The tumors of Wilder and Mandl were classified as malignant adenoma because of the presence of mitotic figures, the polymorphism of the cells, the hyperchromatic nuclei, and in Wilder's case because of the invasion of the neoplastic tissue into the capsule. The striking absence of foam cells and of fat which Wellbrock mentions may not be a criterion of malignancy for the same thing was true in our case and other cases in which the pathological study was reported in detail and in which there was no suggestion of malignancy.

The duration of the bone disease in both Wilder's and Mandl's cases of from 5 to 7 years speaks against a diagnosis of malignant tumor. However a review of the literature of malignant tumors of the thyroid and of the parathyroid glands indicates that in almost every instance tumor of some kind preceded



Fig 6 The tibiae and fibulae showing osteoporosis, thinning of the cortices and inward bowing. May 28 1929

the malignant changes for several years. Balfour, in a series of sixty three cases of malignant struma, found that in not a single case had the condition appeared suddenly, but some form of diffuse or nodular goiter had preceded it. Wilson found that in 157 of 290 cases of malignant goiters, there had been an enlargement for 5 years or longer. In most of the 8 cases of malignant tumors of the parathyroid gland reviewed by T. Kocher, the tumor had been present for many years. Metastases to the neck, mediastinum, or pleura occurred in each of the cases described by Kocher.

In the case of Guy, the tumor of the neck had been noted for 5 years. When removed the section showed a few acini and a few mitotic figures with areas of degeneration and cyst formation resembling those found in Wilder's tumor. A diagnosis of adenoma of the parathyroid gland was made, but the patient returned after 11 months with 3 new nodules near the operative scar. The author noted here that her general health was good and there was no evidence of skeletal disease. These nodules and several glands in the posterior cervical triangle of the neck were removed and all were found to be carcinomatous and all recurred in spite of X-ray therapy. Guy concluded from his studies that apparently benign tumors of years' duration may suddenly take on malignant characteristics. While it is doubtful that the malignant changes in the tumor were responsible for bone changes which have been noted in so many other cases in which there was no suggestion





Fig 4 The proximal ends of the femurs and the pubic and ischial bones showing decalcification and thinning of the cortices May 28 1929



Fig 5 The pelvis and lower lumbar spine showing decalcification May 28 1929

Including the case of Mandl which was reported in 1926, there are descriptions of 8 cases, similar to that here reported from which tumors of one or more parathyroid glands have been removed. In seven of these cases, those of Mandl, Gold Barr, Wilder, Boyd, Snapper, and finally in our own case, a varying amount of improvement followed extirpation of the tumor. It is further learned at the time of going to press with this paper that another case of Barr has been operated on and an adenoma of one of the parathyroid glands removed with beneficial results. Wilder stated that following the removal of the parathyroid tumor in the case which he reported, the patient noted marked improvement in strength and in muscle tone and relief from pain in the bones, and roentgenologically there was some increased density of the bones and disappearance of a tumor of the maxilla. Mandl very recently reported that 3 years after the operation the condition of his patient is still favorable. Before removing the adenoma of the parathyroid gland the patient had been bedridden for months but she now has no pain and is able to take long walks with the aid of a cane.

In the case of Beck, reported in 1928 and diagnosed as generalized osteodystrophia. An olive sized tumor was removed from the lower pole of the right thyroid gland and a coffee bean sized tumor from the site of the upper parathyroid gland on the same side.

The patient developed tetany on the fifth day after and died 20 days after the operation. At autopsy no parathyroids could be found on the left side.

Diagnoses of adenoma of parathyroid glands as an explanation of a condition considered to be due to hyperfunction of the tumorous glands may not be accepted without some criticism. In discussing adenomatous changes in the thyroid gland, Rienhoff (26) declared that even though the cells lining the alveoli do function locally, there is no proof that these neoplasms produce a toxic secretion, and there is no evidence to suggest that these cells lining the alveoli function in such a manner as to affect the organism as a whole. Aschoff did not believe that adenomata of the parathyroid glands had anything to do with the bone changes occasionally found associated with them. Rienhoff (28) also states that adenoma and carcinoma of the parathyroid glands have in some instances been associated with low blood calcium and even with tetany.

Pathologically the tumors in all of the cases reported have been diagnosed adenoma. Functionally they resemble true hyperplasia. Both Ewing and Harbitz have recognized the difficulty of differentiating between a moderate diffuse hyperplasia and a true adenoma of the parathyroid gland. Tumors of the parathyroid gland grossly similar to those reported in this series and associated with similar skeletal conditions were studied by



Fig 10



Fig 11



Fig 12

Fig 10 Cross appearance of tumor. Tissue has been removed from the side of the specimen for microscopic study.

Fig 11 The tumor. The cell structure is compact and

there are numerous alveoli or vesicle like spaces ( $\times 70$ ).

Fig 12 The vesicles of the tumor are lined with cuboid epithelium and in some of them colloid like material is seen ( $\times 150$ ).

of similar conditions. All of the patients in which a case history is given complained of progressive muscular weakness, pain and bowing of the weight bearing extremities and general lassitude. In all of the patients there was osteoporosis of the bones of the skeleton. In the cases in which blood chemistry studies were made there was an elevation of the serum calcium which varied from slightly above the upper limits of normal to the extremely high figure of 23.60 milligrams for each 100 cubic centimeters of serum which was reported by Snapper (Table V). In the 5 cases in which calcium metabolism studies were made, there was a negative balance in each case and in each of these cases the balance became positive following operation except in our own case, for which result an explanation has been offered.

Table V besides illustrating some of the points mentioned of similarity between the various cases reported shows that there were 7 females and 4 males while Bergman does not mention the sex of his patient. Fractures had occurred in 5 of the cases. In the cases of Gold, Barr, and Beck the fractures which had occurred during the course of the disease healed very slowly but in Snapper's case the fractured femur united firmly soon after operation.

An ununited fracture of the femur brought Beck's case to him and symptoms and findings leading to his diagnosis of osteitis fibrosa were brought out during the subsequent examination. The death of this patient on the twenty first day after operation precluded any conclusions regarding the healing of the fracture after removal of the parathyroid adenoma. Tetany was noted after operation in 3 cases. In all cases in which the chemistry of the urine was studied there was found a calciuria and, following removal of the tumor the calcium of the urine fell to below normal values.

Complete descriptions of the roentgenological studies were not included in most of the case reports. In all of the 12 cases there was diminished bone density, spoken of by some as generalized osteoporosis and by others as decalcification. In 6 cases, in addition to the generalized loss of density of the bones, there were cysts of the femurs or of the pelvic bones. These were noted in the cases of Gold, Richardson, Barr, Duken, Wilder, and Snapper. Following removal of the parathyroid tumor Mandl, Richardson, Barr, Wilder, and Snapper reported X-ray evidence of improvement, as shown by increased density in calcium content of the bones. No positive



Fig. 7

Fig. 7 Section taken from the thyroid gland showing the large colloid filled vesicles with smooth lining epithelium ( $\times 150$ )



Fig. 8

Fig. 8 The normal parathyroid gland. The cells which



Fig. 9

resemble epithelial cells are loosely arranged in trabeculae. There are a number of fat cells ( $\times 70$ )

Fig. 9 The normal parathyroid gland showing an occasional acinus ( $\times 150$ )

of carcinoma, the cases in the literature of malignant tumors of parathyroid glands help to substantiate the pathological diagnoses of malignancy in the cases of Wilder and of Mandl.

Richardson, Aub, and Bauer explored the neck of a patient of DuBois with the clinical picture of hyperparathyroidism and after finding no tumor, removed two normal appearing parathyroid glands. The improvement in the condition of the patient which followed this operation was so marked that it indicated that hyperparathyroidism may result from hyperfunction of otherwise normal glands.

Bergman, of Berlin, reported a similar case in which, following studies leading to a diagnosis of generalized osteodystrophia fibrosa the surgeon was not able to find any tumor but did identify four normal parathyroid glands, which he was afraid to disturb.

Duken, of Berlin, basing his conclusion upon the clinical picture adds more cases to the list of those diagnosed as hyperparathyroidism. His patients were the youngest of the series, 1 being 7 years of age and the other 14. A diagnosis of late rickets had been made but from the X-ray and metabolic studies the author made the additional diagnosis of osteodystrophia fibrosa and expressed the belief that the condition was probably due to de-

range of function or to tumors of the parathyroid glands. Palpable tumors similar to those which in other cases had proved to be parathyroid adenomata were noted in the older of his two patients but neither case had been subjected to an operation at the time of his report and his diagnosis had thus not been confirmed. A definite diagnosis by palpation cannot be established between an adenoma projecting from the thyroid and a parathyroid tumor and the presence of a palpable tumor is not essential for the diagnosis as shown by our case.

Intensive metabolic studies in a case of osteomalacia with the effects of treatment over a period of 1 year have recently been reported by Blumgart and his associates. Marked improvement was noted when the patient was given a diet that was rich in vitamin D. When cod liver oil concentrate and ultra violet light were given with adequate amounts of calcium and phosphorus there was calcification of the softened bones and disappearance of all symptoms. On the basis of their results in this case the authors conclude that in their patient osteomalacia was definitely a vitamin deficiency disease.

A review of the symptoms of the patients reported by different writers together with the findings at examination reveals a number

## TABLE VI—RÉSUMÉ OF CASES REPORTED

Case	X-ray		Blood studies Mgm Ca and P per 100 c.c. serum		Mgm Ca excretion in urine for 24 hrs		Symptomatic improvement
	Before operation	After operation	Before operation	After operation	Before op	After op	
1	Generalized osteoporosis	Improvement	None made		54 m m	76 mgm 21 days after	Marked (a net 16 kgm in weight in 2 years)
2	Generalized osteoporosis	Patient died in 27 days					Patient died
3	Generalized osteoporosis	No operation					
4	Generalized osteoporosis and cysts	Not reported	13.5	Ca 9.9 after 27 days	4.2 mgm	26.4 mgm 5 days after	Marked (a net 11 kgm in weight in 11 months after operation)
5	Generalized osteoporosis and cysts	Marked increase in Ca deposits of bones 2 yrs later	85.1 to 15.3 mgm	4 to 3.2 mgm	No appreciable change	6 to 7 times greater than in normal controls	Marked
6	Generalized osteoporosis and cysts	Improvement	16.1	1.4	Tetany after operation		Marked
7	Generalized osteoporosis	No operation	14 mgm	5 mgm			No operation
8	Generalized osteoporosis and cysts	No operation	20.75 mgm	3 mgm			No operation
9	Generalized osteoporosis	No improvement noted in 2 m	17.6 mgm	2 to 3.3			Yes
10	Generalized osteoporosis and cysts	Improvement (2 density of skull too)	11.6 to 8.79	1.71 to 2.18	Ca 9.06 P 8.72 to 7.14 to .99	220 to 340 4 mgm (av) 1 week after	Marked
11	Generalized osteoporosis and cysts	Marked improvement	19.0 to 3.6		Ca 7.2 to 9.04	322 to 411 mgm 2.9 to 4.8 mgm	Yes
12	Generalized osteoporosis	No improvement 10.5 mo	11.5 to 12.55	2.81 to 3.72	Ca 6.97 after 4 days to 1.1 after 4 mo P 4.76 to 5.76	311 (v) 55 (v) during first two weeks after	Yes (net 7.2 kgm within 4 mo after operation)

M tabular studies showed negative balance in cases of Wilder, DuBois, et al, Barr, Byrd et al and in 7 cases. The studies were not carried out in 7 cases not reported; the other cases. In all except our case the balance became positive immediately after removing the tumor.

the skeletal condition present in our case as osteomalacia.

The rather striking similarity between this entity which Barr and his associates have called hyperparathyroidism and rickets is pointed out by Wilder. Treatment with ultra violet light and a diet rich in vitamin D resulted in marked gain in strength and in weight in his case, improvement of anemia and retention of calcium and phosphorus. He suggested that a rôle of vitamin D is the inhibition of the activity of the parathyroid glands. This hypothesis is given additional support by the reports of Starlinger and Blumgart of great improvement in cases of osteomalacia through administration of irradiated ergosterol or of diets rich in vitamin D

and ultra violet light therapy. Likewise, Weil has noticed an improvement of patients suffering from osteodystrophia fibrosa after irradiation of the parathyroids.

### SUMMARY

A case of osteomalacia is reported in which a diagnosis of hyperparathyroidism and tumor of the parathyroid gland was made and confirmed at operation. A second parathyroid was excised and found to be normal.

A resume of 11 other cases which have points of similarity and which have been recently described is briefly discussed.

Symptomatic improvement was noted in our case following removal of the parathyroid adenoma.

TABLE V — RÉSUMÉ OF CASES REPORTED

Case	Age	Diagnosis	Bone cysts reported	Contaminated tumors of bones	Fractures	Tetany after parathyroid	Tumor of parathyroid
1. Mandl	35 Male	Osteitis fibrosa					Adenoma
2. Beck	47 Female	Osteitis fibrosa		Amputation of right leg 1 year and 3 months before	Left femur	Died in tetany 3 days after parathyroid	Adenoma
3. Bergman	Not given	Osteitis fibrosa					No tumor found
4. Gold	54 Female	Osteitis fibrosa	Yes		Left femur poor union		Adenoma
5. Richardson, Aub and Bauer	44 Male	Osteitis fibrosa	Yes		Several	None	No tumor. Two normal glands removed
6. B. Bulger and Dixon	56 Female	Hyperparathyroidism	Yes	Present healed after operation	Right clavicle Left humerus Healed slowly	Yes severe 3 or 4 days after operation	Adenoma
7. Duker Case 1	7 Female	Late rickets and osteodystrophia fibrosa					No operation
8. Duker Case 2	14 Female	Late rickets and osteodystrophia fibrosa	Yes				No operation. Bilateral palpable tumors.
9. Boyd, Millgram and Stearns	1 Male	Osteomalacia or osteitis fibrosa				Chvostek positive No tetany	Cystic adenoma
10. Wilder	39 Female	Osteitis fibrosa	Yes	Healing followed removal of tumor			Malignant adenoma.
11. Snapper	56 Male	Generalized osteitis fibrosa cystica	Yes		Right femur and several others Healed after op.	Positive Chvostek and positive Trousseau's Cramp of hands and carpal spasm	Adenoma.
12. Our case	50 Female	Osteomalacia				Slight twitching	Adenoma

evidence of healing of the bone cysts was included in these reports. In the case of Boyd and his associates, no roentgenological evidence of improvement was noted 2 months after removal of the parathyroid tumor. In our own case the X-ray appearance of the bones remained unchanged more than 7 months after removal of the tumor.

Giant cell tumors of the bones were noted in the cases of Wilder and of Barr and these were found to be healed within a few months after removal of the parathyroid tumor. In the case of Beck the right leg had been amputated following a diagnosis of sarcoma 3 years before the parathyroid tumor was found. When we consider the presence of giant cell tumors in the cases of Wilder and of Barr we are inclined to suggest the possibility that the lesion of the right leg of the case of Beck, which did not recur following amputation

may have been a benign giant cell tumor also.

Based largely upon the X-ray appearance of the bones (Table VI) the diagnosis in 7 of the 12 cases those of Mandl, Beck, Bergman, Gold, Richardson, Wilder and Snapper was generalized osteitis fibrosa or osteitis fibrosa cystica in the cases in which bone cysts were noted. Barr and his associates avoided the issue and made a diagnosis of hyperparathyroidism. Duker classified his 2 cases as late rickets and osteodystrophia fibrosa. Boyd and his associates were undecided whether to call the condition osteomalacia or osteitis fibrosa. Because of the normal appearance of the bone trabeculae, the generalized loss of the calcium salts from the bones, the absence of cyst-like areas, the slight bending of the bones of the weight-bearing extremities and the sinking in of and male type of pelvis we have diagnosed

POSTOPERATIVE PULMONARY COMPLICATIONS AND BRONCHIAL OBSTRUCTION<sup>1</sup>

POSTOPERATIVE BRONCHITIS, ATELECTASIS (APNEUMATOSIS) AND PNEUMONITIS CONSIDERED AS PHASES OF THE SAME SYNDROME

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IT is the aim of this paper to show the very close relation between the postoperative pulmonary complications usually described as postoperative bronchitis, atelectasis, and pneumonia, furthermore to show that these conditions generally follow one another in the order named without clear cut distinctive signs and that they represent evolutionary phases of one and the same postoperative pathological process—bronchial obstruction.

This theory if correct is of far more than theoretic interest. It is of practical importance because it is only with exact knowledge of the etiology and interrelation of these postoperative complications that we shall be able to establish a rational curative treatment based not on the symptoms but on the causes and furthermore that we shall be able to introduce efficient prophylactic measures.

The study of massive atelectasis so thoroughly carried out in recent years gives I believe the key to the solution of the important problem of postoperative pulmonary complications—factors of such prime importance to the surgeon.

In his commendable papers Elwyn (46) gives his opinion on the etiology of postoperative pneumonia which in essence is as follows: There is first a partial or total collapse of the lung; if the affected part does not expand within 24 to 48 hours pneumonia may develop depending merely upon the presence or absence of bronchial inflammation and upon the extent and severity of such inflammation. But he concludes: 'This explanation does not entirely solve the problem, it merely puts it back a step further. The question is how does the collapse of the lung arise?' At present we have no answer. It is exactly the purpose of this paper to endeavor to answer this question.

In previous studies on atelectasis and experimental and human lobar pneumonia Coryllos and Birnbaum (27, 28, 29) came to the conclusion that pneumococcus lobar pneumonia is a pneumococcal lobar atelectasis. In support of this view were presented experimental and clinical evidence to show that both conditions are accidents in the course of pneumococcal bronchitis and are due to the obstruction of bronchi by bronchial secretions or exudate. Differences in clinical evolution depend upon the presence, type and virulence of the microorganisms present in the occluding secretion or exudate.

Further study of postoperative complications offered new evidence in favor of this theory. Briefly stated, I believe that because of the stagnation in the bronchial tree of bronchial secretions or exudate after operation a bronchial occlusion may ensue and lead to atelectasis. The size of the obstructed bronchus determines the anatomical distribution of the disease—whether it will be multilobar, lobar or lobular. The outstanding factor in the production of these complications would therefore, be *bronchial occlusion and suppression of the free drainage of the pulmonary airways* by means of which normally the lung is maintained in an aseptic condition even though a great number of microorganisms are introduced with the inspired air. When bronchial obstruction is once established the type of complication will depend upon the microbes present in the bronchial exudate: aerobes and anaerobes as pneumococcus, streptococcus, staphylococcus, influenza bacillus, spirochæta, fusiform bacillus, perfringens, etc.—all normally or accidentally present in the upper respiratory tract may play a part. I certainly do not exclude the possibility of postoperative pulmonary complications secondary to large or

<sup>1</sup>From the Laboratory of Surgical Research, Cornell Medical College, New York. Received for publication, September 10, 1934.

While removal of the tumors of the parathyroid glands has not resulted in complete recovery in reported cases, the symptomatic improvement, the chemical evidence of increased calcium retention, and the X-ray evidence of increased density of the bones in a few cases followed for a long enough period after operation are results which, as the operative risk is slight, do warrant surgical intervention in cases such as that reported here

## BIBLIOGRAPHY

- 1 ASCHOFF LUDWIG Epithelkörperchen Quoted by E V Guerke Pathologische Anatomie Vol 2 pp 925-929 Jena Fischer 1923
- 2 BALFOUR D C Cancer of the thyroid gland Med Rec N Y 1918 xciv 846-850
- 3 BARR D P BULGER H A and DRYON H H Hyperparathyroidism J Am M Ass 1929 xcii 951-952
- 4 BECK ALFRED Aussprache Arch f klin Chir 1918 cli 123-124
- 5 BERGMAN (Berlin) Discussion Arch f klin Chir 1928 cli 125
- 6 BLUMGAERT HERMAN L CARROLL S L and GILIGAN DOROTHY R Osteomalacia a study of its metabolism and treatment Tr Ass Am Physicians 1929 xlv 243-253
- 7 BOYD JULIAN D MILGRAM J E and STEARNS GENEVIEVE Clinical hyperparathyroidism J Am M Ass 1919 xciv 684-688
- 8 CLARK E P and COLLIP J B A study of the Tisdall method for the determination of blood serum calcium with a suggested modification J Biol Chem 1925 lxxi 461-464
- 9 DLAEN J Beitrag zur Kenntnis der malacischen Erkrankungen des kindlichen Skelettsystems Späet rachitis und Osteody atrophica fibrosa Ztschr f Kinderh 1928 xlii 114-116
- 10 ERDMANN J Quoted by Biedl Artur Innere Sekretion 2d ed pt 1 p 103 Berlin Urban and Schwarzenberg 1913
- 11 ERDMANN J Tumor des Epithelkörperchens Beitr z path Anat u z allg Path 1903 xxxiii 214-218
- 12 EWING J Neoplastic Diseases 2d ed p 909 Philadelphia and London W B Saunders Company 1921
- 13 FISKE C H and SUBBARROW Y The colorimetric determination of phosphorus J Biol Chem 1925 lxxi 375-400
- 14 GOLD H Entfernung eines Epithelkörperchentumors wegen Ostitis fibrosa Wien med Wchnschr 1921 lxxvii 1734
- 15 GUY C C Tumors of the parathyroid gland Surg Gynec & Obst 1919 clviii 557-565
- 16 HARBITZ F On tumors of the parathyroid glands J Med Research 1915 xxxii 361-375
- 17 HASTINGS A BARD and SENDROW J L S Ja The colorimetric determination of blood pH at body temperature without buffer standards J Biol Chem 1924 lxx 695-710
- 18 KOCHER T Zur klinischen Beurteilung der bösartigen Geschwülste der Schilddrüse Deutsche Ztschr f Chir 1908 xci 197-307
- 19 MANDEL F Therapeutischer Versuch bei einem Falle von Ostitis fibrosa generalisata mittels Ex tirpation eines Epithelkörperchentumors Zentralbl f Chir 1926 lxx 260-264 Zentralbl f Chir 1919 lxx 1779-1792
- 20 MARECH Quoted from J Mouzon La Parathyroidectomie Presse méd 1920 xxxix 637-640
- 21 MATTHEWS A P Physiological chemistry 4th ed New York William Wood and Company 1917 pp 994-995
- 22 McCANDLESS J M and BURTON J Q Sources of error in the determination of phosphoric acid by the molybdate magnesia method Ind & Eng Chem 1924 xvi 1267-1270
- 23 McCLEDDEN F H The determination of calcium in the presence of magnesium and phosphates The determination of calcium in urine J Biol Chem 1911 x 187-199
- 24 NEUMANN ALBERT Einfache Veraschungsmethode (Säuregemisch Veraschung) und vereinfachte Bestimmungen von Eisen Phosphorsäure Salzsäure und anderen aschenbestandtheilen unter Benützung dieser Säuregemisch Veraschung Ztschr f phys Chem 1902 xxxvii 115-142
- 25 RICHARDSON E P AUB J C and BAKER W Parathyroidectomy in osteomalacia Ann Surg 1919 xc 730-741
- 26 RIENHOFF W F Benign tumors of the thyroid gland Dean Lewis Practice of Surgery 1919 vi 190-197 Hagerstown Maryland W F Prior Company 1919
- 27 Idem Malignant tumors of the thyroid gland Dean Lewis Practice of Surgery 1919 vi 197-231 Hagerstown Maryland W F Prior Company 1919
- 28 Idem Diseases of the parathyroid glands Dean Lewis Practice of Surgery 1929 vi 1-20 Hagerstown Maryland W F Prior Company 1929
- 29 SCHALGENBACHER Quoted by J Mouzon La Parathyroidectomie Presse méd 1919 xxxix 637-640
- 30 SHOFK A T The effect of hydrogen ion concentration upon the determination of calcium J Biol Chem 1922 i 527-533
- 31 SNAPPER I Gezwel van een burschildlier en skeletafwijkingen Nederl Tijdschr v Geneesk 1929 cli 4759-4773
- 32 STÄRLINGER W Ueber die Beeinflussung des Verlaufes einer schweren Osteomalacie durch beständiges Ergosterin Deutsche med Wchnschr 1917 li 1533-1554
- 33 STRAUSS B Tumors of parathyroids and relation to osteomalacia Frankfurt Ztschr f Path 1912 cxviii 319
- 34 TILDALL F F and KRAMER B Methods for the direct quantitative determination of sodium potassium calcium and magnesium in urine J Biol Chem 1924 lxx 53-573
- 35 VANSLYKE D D and NEILL J M The determination of gases in blood and other solutions by vacuum extraction and manometric measurement J Biol Chem 1914 lxi 5-573
- 36 WEIZ Quoted by Duken Ztschr f Kinderh 1928 xlii 114-116
- 37 WELLSOCK W L A Malignant adenoma of the parathyroid glands Endocrinology 1929 xii 85-204
- 38 WILDER R M Hyperparathyroidism tumor of the parathyroid glands associated with ostitis fibrosa Endocrinology 1929 xii 237-44
- 39 WILSON L B Malignant tumors of the thyroid Ann Surg 1921 lxxi 19-184



Fig 3 Dog B 52 Obstructive atelectasis of middle and inferior right lobes. The obstructing balloon is filled with sodium bromide and it is visible in the right common bronchus. The pulmonary vessels are injected with lipiodol, the injection being made into the jugular vein on the living animal. The branches of the pulmonary artery are perfectly injected. There is no difference whatever between the vessels of the healthy (left lung and upper right lobe) and the atelectatic portions of the lung. (Roentgenogram of the lungs extracted from the chest.)

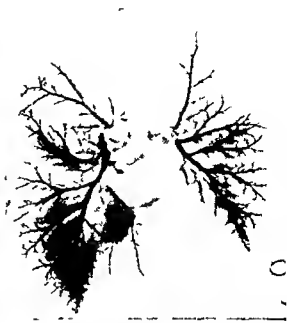


Fig 4 Dog B 57 Experimental pneumonia of the right lower and subcardiac lobes. (Twenty-four hours after insufflation through the bronchoscope into the right common bronchus of 10 cubic centimeters of pneumococcus type one culture.) Lipiodol injection on the living animal same technique as in Figure 3. There is no difference between the healthy and consolidated lobes. (Roentgenogram of the lungs extracted from the chest.)

atelectasis. In a recent paper, Lee, Clerf, and Tucker have given a practical demonstration in support of this theory. They cured postoperative atelectasis by bronchoscopic aspiration of the mucous exudate and produced a typical atelectasis in the anesthetized dog by introducing into its right bronchus the material which was aspirated from the patient.

Although it is almost universally conceded that a complete occlusion of a bronchus produces an atelectasis because of subsequent absorption of alveolar air, there is much discussion about the mechanism of the obstruction in postoperative atelectasis. A clear conception of this phase of the problem will go a long way toward solving its difficulties.

In the main, two theories are supported. One is the 'nervous reflex theory' and the other the 'mechanical occlusion of a bronchus by bronchial secretions.' I firmly believe that the key to the solution of the whole

question of postoperative pulmonary complications lies in a clear understanding of these theories, and it will be well worth our effort to discuss their merits fully.



Fig 5 Dog B 76. Roentgenogram of the heart of an atelectatic dog injected with lipiodol through the jugular vein. (Same technique as Figures 3 and 4.) The right heart is filled up with oil, but none passed into the left heart.





Fig 1 Dog 195 Photomicrograph of experimental obstructive atelectasis Simple uncomplicated pneumonia Notice the dilated vessels Compare with Figure 7

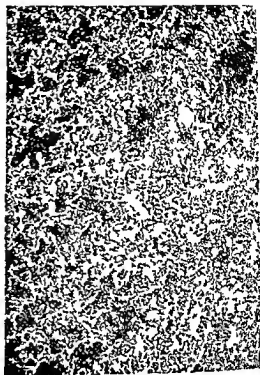


Fig 2 Dog 199 Experimental obstructive massive atelectasis Complicated by pneumonia Dilated vessels are easily distinguished Compare with Figure 9

small emboli But I believe with Wharton and Pierson (130) that embolism can and should be differentiated from the 'inflammatory lesions' with which I am dealing

Under different headings are to be considered First, the etiology of postoperative atelectasis and of postoperative pneumonia, second a comparative study of their similarities third a discussion of the theory proposed and lastly, an outline of a new prophylactic and curative measures

#### ETIOLOGY OF POSTOPERATIVE MASSIVE ATELECTASIS

Massive atelectasis can no longer be considered as a rare postoperative complication I completely agree with the opinions of Mastics, Spittler and McNamee and Lee Clerf, and Tucker, that the incidence of this complication is not as low as has been stated 0.6 per cent by Scott and Cutler 0.8 per cent by Pasteur (99), and 1.3 per cent by Scrimger,

but that it is in its different forms, lobular lobar or massive, closer to 50 to 70 per cent I only want to add that a great number of evanescent forms of atelectasis are often undiagnosed when they do not give rise to marked clinical symptoms or are diagnosed as 'congestion' or 'hypostasis' of the lung

In a previous paper (29) the different theories for the etiology of this condition were extensively discussed and experimental and clinical evidence was given in favor of the theory of mechanical obstruction of a bronchus by mucous exudate

This theory first confirmed experimentally by Lichtheim in 1879 and supported by Elliott and Dingley was given clinical proof by the work of Jackson and Lee Tucker Clerf Harrington Hearn and others who by repeated bronchoscopic examinations not only verified the occlusion, but by aspirating the occluding mucus, produced rapid inflation of the diseased lung and cured the

vagal section can lead to a collapse of the smaller bronchi from *paralysis* of their muscular layer

Moore objects to Scafer's opinion on the ground that if it were correct section of the vagus should result in a decrease of tidal air in the corresponding lung. Moore's experiments showed exactly the opposite. Immediately following a right vagotomy the tidal air of the right lung rose to 55 cubic centimeters (from 44) and of the left lung to 72 cubic centimeters (from 56 cubic centimeters), and later to 100 cubic centimeters on the right and 138 cubic centimeters on the left."

3 *Vasomotor reflex theory* Gwyn in 1923 suggested vasomotor disturbance of the pulmonary circulation as a possible cause of atelectasis. Scott and Cutler, after stating that many etiological factors have been proposed but that no primary cause has been found, express their belief that the "process is initiated by a nervous reflex probably largely vasomotor, which results in a narrowing of the lumina of the peripheral bronchioles by venous engorgement, swelling of the mucous membrane, and the elaboration of a tenacious secretion." Among the important factors contributing to the completion the extent, and the localization of the complication they consider the quantitative changes in ventilation. They believed the diminished ventilation to be not a result but a cause of atelectasis. Lee in 1924, admitted as possible causes, besides obstruction of the corresponding bronchus, "possibly some paralysis or bronchial spasm due to a reflex irritation from other parts in the body." In his more recent paper (Lee with Tucker and Clerf, 1928), he modifies this opinion and considers that at least the most important factors in the production of apneumotosis are "viscid bronchial secretion and some inhibition of coughing."

Fontaine, Lenormant and Iselin more recently upheld the same opinion. "Up to this time," says Fontaine "atelectasis has been experimentally produced only by bronchial obstruction. It seems, however, that the pulmonary nerves have a preponderant part in the production of this symptom in the

human. If the direct irritation of the nervous fibres is responsible for massive atelectasis it must act through bronchospasm or reflex vasomotor influence." But he admits that "So far, no definite data have been produced in favor of this hypothesis." Roullard (1929) does not express any definite opinion although he considers as possible reflex motor disturbances and congestion of the atelectatic lung which could explain the greater opacity of this lung as compared with the simple collapsed lung in pneumothorax. Bowen (1929) in a painstaking paper, containing the most complete historical review of the question, adheres unreservedly to the occlusion theory.

H. Santee and Bergamini and Shepard reported two rapidly fatal cases of bilateral atelectasis and suggested as the cause a vasomotor reflex or an angioneurotic edema, because of the rapid development of the disease, the engorgement of the capillaries, and the absence of bronchial occlusion at autopsy.

Fontaine and Hermann reported the results of experimental extirpation of all the extrinsic nerves to one lung in the dog. It is interesting that of the ten dogs used in their experimental work atelectasis occurred suddenly in only one of them on the third day after operation. No bronchial occlusion was found at autopsy, they conclude that "if there were any reflex responsible for this collapse the impulse must have come by way of the anastomotic branches from the opposite side or they must have originated in the peripheral ganglion of the affected lung." It will be interesting before closing this brief resume of the different reflex theories to report the experimental findings of Einthoven. After section of the vagi he did not notice the slightest modification in the intrapulmonary pressure or any noticeable changes in the cross section of the bronchioles. He concluded that when the bronchial muscles are at rest, the vagi exert little or no tonic effect upon them.

#### COMMENT ON THE NERVOUS REFLEX THEORIES

The theories attributing atelectasis to *paralysis of the diaphragm* (reflex or organic)

## NERVOUS REFLEX THEORY

There is no single nervous reflex theory, different authors describe different reflexes originating at different points, transmitted by different pathways and producing the same result in different ways. They can be classified as (1) the diaphragmatic, (2) the bronchoconstrictor, (3) the vasomotor. I shall give a resume of each of them and then discuss them.

1 *Diaphragmatic and muscular theory* W. Pasteur considered atelectasis secondary to paralysis of the diaphragm, whereas Briscoe considered it secondary "to a disturbance of the functions of the diaphragm and associated respiratory muscles due to inflammation affecting the retroperitoneal portion of the diaphragm." Soltau and Soltau and Alexander and Watson and Meighan believed that a reflex paralysis of the diaphragm was brought about by afferent impulses being conveyed to the respiratory center from the focus of irritation by way of the vagus, the efferent impulses being conveyed by way of the phrenic nerve. Ball considers diaphragmatic fixation as a possible cause of atelectasis in his case of suppurative pancreatitis with an occluded foramen of Winslow. Bradford suggested spastic contraction of the respiratory muscles as a factor. L. Sante believes that several factors existing simultaneously are necessary for the production of the condition such as inhibition of cough reflex by some toxic reflex stimulus in connection with an impairment of the respiratory function and immobilization of the respiratory muscles from a defense reaction or paralysis from toxic neuritis. This in time permits accumulation of secretion blocking the bronchi and results in atelectasis.

2 *Bronchoconstrictor theory* The principal defender of this theory is Churchill who in his exhaustive paper concludes that atelectasis is due to a combination of weakened respiratory force and bronchoconstriction. Experimental support of this theory is presented in the work of Dixon and Brodie (16, 17, 36) who enclosed the lung in an *oncometer* and were able to produce bronchoconstriction or dilatation either by direct vagal stimulation or by means of injected drugs. Under

these conditions they produced either distention or collapse of the lung by varying the force of inflation and the time allowed for deflation. With rapid forceful artificial respiration which allowed only a short time for expiration, bronchoconstriction commonly produced distention. With forceful artificial respiration and intervals sufficiently long to allow full expirations constriction of the bronchioles resulted in collapse. They found that a lobe collapsed in such a manner, usually remained so, even after bronchial constriction had passed off. Churchill compares the condition of postoperative patients to that of experimental animals of Dixon and Brodie (36) because in the former shortened inspiration and prolonged expiration are present. It is to be noted however, that Churchill fully admits the possibility of bronchial obstruction by inflammatory exudate or even normal secretion.

Scott and Joelson consider that atelectasis is generally bilateral and is due to bilateral reflex. "In both lungs they say 'the lumina of the finer air passages are undergoing variation in size resulting from alterations of bronchomotor or vasomotor tone.' But they add, 'the initial reflex is possibly vasodilator in character, and the most striking feature is an extreme pulmonary congestion, almost an angiomatous condition.' In order to explain the transformation from the initial bilateral to a subsequent unilateral atelectasis they suggest that possibly the obstruction becomes complete on the dependent side because 'of greater congestion of the dilated pulmonary capillaries and of a compensatory hyperventilation of the other side which keeps those respiratory passages open. Should such hyperventilation fail to take place bilateral instead of unilateral atelectasis is produced. The above is a combined bronchomotor and vasomotor theory. L. Sante (119) expressed a similar opinion in 1927. 'the cause is not known but it seems most probable that some infection or insult to the region of the vagus supply produces a reflex on the bronchioles permitting their temporary collapse.

As against the reflex bronchoconstrictor theory Scafer calls attention to the fact that

contraction of the bronchial muscles there is no atelectasis but on the contrary an emphysema. In allergic asthma, in anaphylactic shock of the lung in the guinea pig, and in reflex asthma due to irritation of the nasal mucosa, there is always emphysema and not atelectasis. Dixon and Brodie believed that both constrictor and dilator fibers in the vagus supply the lung on the same side only, and only very few crossed fibers exist. Moore, however, proved that cutting one vagus produces a response from both lungs. How then, shall we explain by a bronchoconstrictor reflex the cases of bilateral or contralateral atelectasis, if we accept the first view? How will the cases of H. Santee, Bergamini and Shepard (bilateral atelectasis), and the case of the dog with denervated lung of Fontaine and Hermann be explained? Again if Moore's view is correct, why is the disease lobar and not diffuse and patchy in distribution as it obviously is in cases of emphysema due to bronchoconstriction? For these reasons I believe that bronchoconstriction cannot and should not be considered as a primary cause of massive atelectasis.

3. *The vasomotor reflex.* The last variety of nervous reflex to be discussed has neither clinical nor experimental facts in its support. There is a mere supposition based upon the pathological findings of distended vessels in microscopic sections, upon the two cases of Bergamini and Shepard in which complete bilateral collapse developed while the patient was still on the operating table and upon the cases in which no bronchial obstruction was found at postmortem examination. At first it would seem that the cases of Bergamini and Shepard could not be explained by bronchial obstruction with mucus even if such obstruction were found because complete absorption of the air by the alveolar blood cannot be completed in such a short time. In fact it is known that, although absorption of oxygen and carbon dioxide is completed in a very short time, nitrogen requires 10 to 20 hours. This difficulty, however, is only apparent. My explanation of the two cases of H. Santee and of Bergamini and Shepard is as follows:

These patients were under deep gas oxygen ether narcosis and breathed in air saturated with ether and nitrous oxide, consequently the rapidity of completion of atelectasis in these two cases would depend upon the absorption coefficient of the gases present in the alveolar air. Teschendorf (1924), studying the time of absorption of different gases in the pleural cavity (where the gases are absorbed by the alveolar capillaries less rapidly than when introduced into the lung), has found that carbon dioxide is so rapidly absorbed that it is impossible to produce a pneumothorax with even 600 or 700 cubic centimeters introduced into the pleural cavity of man. The absorption coefficient of carbon dioxide at 0 degrees C is 1:7967, of ethylene gas, 0.0946, and of nitrous oxide, 1:3052. The absorption of ethylene gas requires a few minutes, and the absorption of carbon dioxide and nitrous oxide is instantaneous. Van Mechelen in his paper "Ether Narcosis" writes: "The diffusion of ether in the blood of the lung capillaries is so rapid that within 2 seconds 95 per cent of even a massive dose of ether is absorbed." After one single inspiration of 500 to 800 cubic centimeters of air containing 39 per cent ether, only 0.2 gram are found in the expired air, the proportion of the absorbed ether is in direct proportion of its concentration in the inhaled air and in the anesthetic mixture the quantity of nitrogen is negligible. These facts give the explanation of the almost instantaneous absorption of the anesthetic mixture in case of bronchial obstruction and of the rapid development of atelectasis, as in the cases of Bergamini and Shepard (7) and the case of Lüthenthal. The only remaining argument is that no obstructing plug was found at autopsy. However, it will be shown later that a real "plug" is not necessary to occlude a bronchus and produce atelectasis, but that even a thin secretion may cause this condition if the means of defense of the lung are sufficiently lowered.

So far as the atelectatic dog of Fontaine and Hermann is concerned, I can hardly believe that it presented true atelectasis. The interpretation of the findings in this animal is really puzzling. By a left thoracic incision

<sup>1</sup> I had the opportunity of discussing the above cases personally with Dr. Bergamini who accepted the explanation given here.

or to its fixation, are no longer tenable. It is generally admitted that these conditions can not produce massive atelectasis. In cases of fixed deviation of the diaphragm (as in the case of Ball), we might perhaps have small atelectatic areas, as with pneumothorax or pleural exudate from compression of the lung. But this is totally different from massive atelectasis. It has been demonstrated that from phrenicotomy alone in humans or animals atelectasis does not occur and further more that the elevation of the diaphragm is not the cause of the atelectasis but the effect of it. Corvillo and Burnbaum (5) showed that if in dogs with phrenic nerve sectioned on one side atelectasis by bronchial obstruction is produced on the other side the diaphragm corresponding to the atelectatic lung will rise and even to a higher level than the paralyzed one.

I think for these reasons that the theory of diaphragmatic origin of the atelectasis should be definitely discarded at least as a primary and determining cause.

*The reflex bronchoconstrictor theory.* As a primary cause of massive atelectasis this theory has no clinical facts in its support. We know for example of no case in which reflex irritation of the nasal mucosa has produced atelectasis whereas this irritation often causes inflation of the lungs and asthmatic attacks. Dixon and Brodie on whose experimental work Churchill bases this hypothesis state that a reflex bronchial constriction is experimentally obtained by exciting the nasal mucous membrane and that little or no result from stimulating the central vagus superior laryngeal, or corneal nerves is obtained. These same authors state that atropine produces paralysis of the bronchial muscles and dilatation of the bronchi. This fact is of importance in connection with the case of postoperative atelectasis reported by Scott (Case 35 of this author) in which 75 milligrams (almost  $1\frac{1}{2}$  gram) of atropine was administered within 30 minutes in 3 doses, while the patient was under fluoroscopic examination and atelectasis persisted. Not only was there no decrease in the density of the lung, or the displacement of the heart but on the contrary, rather a slight increase

was noticed. Adrenalin did not have any effect either, although Dixon and Ranson have proved that adrenalin produces an active bronchial dilatation especially marked when an increased tonus of the bronchi is present, the same striking effect should have been noticed in atelectasis if this condition were due to bronchoconstriction,—as occurs in cases of asthma, nor can the view be sustained that bronchoconstriction starts the atelectasis and the bronchioles are subsequently completely obstructed with mucous exudate, as was suggested by Scott and Jocson because in that case why should the bronchioles of one particular lobe only be affected and not of the other lobes? Why is there a characteristic lobar distribution of the disease if spastic contraction or occlusion of the small bronchioles is the cause?

Only a mechanical occlusion of a bigger bronchus supplying the whole lobe can explain the lobar distribution of the disease and a large bronchus cannot be constricted by a reflex or otherwise. Starling (131 p. 897) states that 'under the influence of vagal stimulation or inhalation of carbon dioxide expiration and not inspiration will be rendered more difficult because of the different mechanical conditions of the bronchi during the two phases of respiration. Not only the elastic structure of the lung is pulling upon the bronchial wall tending to maintain it patent and so opposes the action of the bronchial muscles. During inspiration this expanding force is so increased that in the presence of bronchial constriction the ingress of the air is rendered easier the more powerful is the contraction of the inspiratory muscles. On expiration on the contrary all parts of the lung collapse drawn in by the chest wall. The pull of the lung tissue on the bronchial wall is lessened but is still present. If however the respiratory muscles contract vigorously the intrapleural pressure becomes positive and the pull of the lung tissue on the bronchial walls is changed into a pressure tending to obliterate their lumen and so impeding the outflow of air.' This physiological mechanism is fully justified by clinical fact. In hyper-sensitization of the parasympathetic system (vagotonia) with spastic

capillaries would not favor atelectasis, because vasodilation, by increasing the blood supply through the lung, would on the contrary tend to increase the air content of this organ. In a study of "vital capacity in intrathoracic therapy" Yates states that deliveries of blood through bronchial arteries and through the pulmonary arteries are controlled by the functional activities of the lungs which are proportionate to vital capacities. When the air cells are inflated the capillaries are elongated and as they carry the air cells with them inflation is increased. These activities and reactions also take place in reverse order. In other words blood flow and vital capacity follow parallel courses. Whatever may be the objection to this theory of air cell capillary mechanism which is supported by E. K. Dunham, Yates says that the fact remains that, in the normal lung, expansion is accompanied by an increased blood flow through the lungs.

This being the case, how can we reconcile the above facts with the microscopic findings in sections of atelectatic lung where there is to be found dilation of the small vessels? This fact was reported by several authors and vented by ourselves in our cases of experimental atelectasis in dogs (Figs 1 and 2). We think that this contradiction is only apparent, *in fact the impairment of the circulation through the capillaries in atelectasis is progressive and proportional to the degree of absorption of air and of collapse of the alveoli.* The capillaries become more and more retracted as the atelectasis advances and as a result there is stasis in the pulmonary arterioles. What appear to be dilated capillaries in microscopic sections, are, in reality dilated terminal arterioles, the circulation in the capillaries is actually greatly impaired, and the apparent vasodilation is not the cause but the result of pulmonary atelectasis. This was proved by Coryllos and Birnbaum (26) by injecting lipiodol or India ink into the jugular vein of the living animals in which atelectasis was produced. Lipiodol injected into the jugular vein penetrates the small arterioles but not the capillaries of the lung. Ten to forty cubic centimeters of lipiodol (iodized oil) or even more have been

injected into the jugular vein, with survival of the animal from 3 to 10 minutes after the injection. Sufficient time was thus allowed the circulating blood to carry the lipiodol to the lung. Roentgenograms showed the finest details of the arterial tree (Figs 3 and 4), but whereas the right heart was filled with lipiodol no trace was seen in the left heart, although the aorta was clamped for avoiding dilution of the lipiodol (Fig 5), which shows that lipiodol does not pass through the capillaries. If now instead of using lipiodol the living animal is injected through the jugular vein with a 20 per cent solution of India ink in Ringer's solution according to the method of Krogh and Ehrlich, this passes through the capillaries which are readily injected. Microscopic sections show that capillary circulation in the atelectatic lung is markedly impaired and that differences between the healthy and atelectatic lung are conspicuous (Figs 6, 7, 8, 9, 10, and 11). As it is shown in these illustrations, the same procedure applied to the pneumonic lung yielded exactly the same pictures. This is a new and quite unexpected argument in favor of the conception developed by Coryllos and Birnbaum that lobar pneumonia should be considered as pneumococcal atelectasis (27). It throws a new light on the real mechanism of the impairment of the circulation in the consolidated pneumonic lung. From data to be published later with Dr. Birnbaum I can state here that this impairment would be due neither to thrombosis of the capillaries (Riebert, Kline and Winternitz) nor to the pressure exerted upon the capillaries by the exudate filling the air cells (Binger and Christie), but to retraction of the capillaries due to the collapse of the alveoli. This would explain the rapid reestablishment of the circulation when the lung is aerated again, both in pneumonia and atelectasis, and would offer a new argument in favor of the theory of the close relation between these two diseases.

A last argument against the reflex nervous theory lies in the fact that by rolling a patient back and forth in the treatment of atelectasis, as shown by Sante, a coughing spell is induced and in many instances with the expectoration of thick sputum a clearing up

the entire vagosympathetic supply of the left lung was carefully excised and a piece of the left lung was removed for microscopic study and the pulmonary wound ligated, this fact is not mentioned in the text but it is reported in the legend of the figure. The chest was then closed in an air tight way after inflation of the lung. Three days later the animal was in good condition, it was placed on the table for taking a specimen of blood, suddenly it became cyanotic, very dyspnoic, and died in a very short time. In the roentgenogram (which is not given in his paper) "there were signs of atelectasis but without displacement of the heart or trachea." This absence of displacement was attributed by the authors to the "tearing of the flimsy and nonresistant mediastinum of the dog because of the rapid development of atelectasis." It is difficult to understand how the perfectly elastic mediastinum of a dog can be torn "by the rapid development of atelectasis," it never happened in my experimental thoracic work, but even if such were the case, the heart and trachea should have been displaced just the same, as the mediastinum of the dog normally does not impede the passage of air or fluid through it. The diminution in size of the atelectatic lung is the only factor responsible for the displacement of the mediastinal contents heart and trachea in atelectasis. The only thing the mediastinal membrane itself can do is to resist this displacement, so that with a torn mediastinal membrane the displacement should be even greater. I personally believe that the animal died because of the sudden production of a pneumothorax due to the sloughing off of the pulmonary ligatures in the area from which the lung specimen was taken and this would probably account for the non displacement of the heart to the affected side. Besides it would be very difficult to consider that in the denervated left lung the atelectasis was caused by vagus reflex transmitted "through the plexus of the right lung" while this latter lung remained completely sound.

Having cleared the way I believe, of these 3 cases, I shall now briefly present what I consider physiological evidence against the so-called "vasomotor reflex."

Brodie and Dixon, in an exhaustive study of the innervation of the blood vessels of the lung came to the conclusion that "pulmonary arterioles possess no vasomotor nerve supply. They have never obtained the least effect upon the pulmonary blood by exciting the white rami communicantes from the upper thoracic spinal nerves, the sympathetic chain between the successive ganglia, stellate ganglion, the annular loop of Vieussens or the inferior cervical ganglion. Stimulation of the fibers at the root of the lung was ineffective. The results were the same in the dog, cat, or rabbit. Stimulation of the vagus was equally without effect, nor were they able to discover any vasodilator fibers to the lung in any of the nerves investigated. According to Starling even if they exist vasomotor nerves to the pulmonary vessels are of little importance.

It is not my intention here to discuss at length this phase of the subject. This question is taken up in detail in a forthcoming paper on the circulation in the atelectatic and pneumonic lung. Weber upholds the existence of vasomotor nerves to the lung, but Krogh has shown that all the "active vasomotor phenomena," supposed by Weber to occur in the pulmonary lobe enclosed in a plethysmograph with its bronchus tied are due to increased or decreased output of the right heart and not to vasomotor nerves. Krogh concluded that "the evidence obtained from Weber's experiments is not favorable to the theory of pulmonary vasomotors." I personally believe that if the atelectasis were due to the mechanical expression of air caused by vessels so greatly dilated as to give the lung "an angiomatous" appearance (Bergamini and Shepard) then that lung should be at least as large and not smaller than the healthy one as it really is in order to produce that mechanical expression of the alveolar air the dilated vessels would have to take the place of the actual alveolar space. Moreover even if reflex vasodilation were possible in a healthy lung inflation and not collapse of the lung would be produced. Vasodilation of the capillaries around the bronchi and narrowing of the bronchial diameter would produce emphysema for the reasons mentioned above, vasodilation of the alveolar

pneumonitis had greatly diminished or even disappeared, the papers of Finsterlin, Hackenbruch, Reinhard, Roith, and others showed that its frequency and resulting mortality were about the same as with general anesthesia. Lichtenberg (83), Demmer, Pinner and Gottstein believed that the incidence was even greater after local anesthesia.

In the more recent papers of Minell, Cutler and Morton, Cutler and Hunt, Whipple, Elwyn (46), Cleveland, etc. the facts mentioned are corroborated. The question therefore, naturally arises as to the etiology and pathogenesis of postoperative pneumonitis.

The principal etiological factors brought forward are: Aspiration of septic contents of the mouth, hypostatic congestion, chilling, embolism and retention of mucous secretion in the bronchi.

#### ASPIRATION PNEUMONITIS

Despite the opinion of Chlumsky, Hoelscher and others, it is very improbable that a true aspiration pneumonia exists. I agree with L. Sinte (1928) who says that aspiration alone could hardly explain the condition since patients aspirating barium sulphate through bronchoscopic instillations never develop atelectasis. Likewise postoperative pneumonia is a rarity after tonsillectomy and there is abundant proof of the extreme degree of aspiration which frequently occurs during this operation. It is known that during general anesthesia or even local anesthesia of the larynx, much infectious material passes from the mouth into the trachea. Myerson found blood in the bronchi of 75 of 100 cases bronchoscoped after tonsillectomy. Lipiodol passes into the trachea when instilled into the pharynx if the larynx is anesthetized (Singer). Wessler has shown that aspiration produces suppuration and gangrene of the lung but, as Elwyn (47) points out, aspiration does not explain the occurrence of pneumonia within a day or two of operation and especially of that type of pneumonitis which disappears after 3 to 7 days with no evidence of pus formation. Furthermore, pneumonitis is more frequent after operations upon the abdomen than in operations on the

mouth, head, or neck performed either with general or local anesthesia, although these procedures do remarkably favor aspiration. In discussing the embolic theory I shall quote respective figures of pneumonitis after operation upon the abdomen and other parts of the body, including the head and mouth, which will show clearly that aspiration of septic material, which to my mind constitutes the principal cause of abscess and gangrene of the lung, cannot be considered as the determining cause of postoperative pneumonitis.

#### PULMONARY HYPOTENSIS

With regard to *hypostatic congestion* (as in bedridden, cachectic patients or patients with advanced diseases of the cardiopulmonary circulation) it might be considered a contributing cause for development of pneumonitis because of the increased bronchorrhea, posture and impairment of the physiological defense of the lung. But to consider it as a determining etiological factor, *per se*, serves rather to confuse than to clarify the situation. Diminished respiratory activity, the recumbent position or wasting illness alone cannot be the cause of postoperative pneumonitis which appears as well in strong, young people with healthy cardiovascular systems. I shall only remark that under the same conditions atelectasis was said to develop and a similar discussion has been going on as we have already seen.

#### EMBOLIC THEORY

The embolic origin of postoperative pulmonary complications has had many staunch supporters. Lichtenberg (84), particularly, stressed its importance. Woller thought that the migration of thrombi from the pampiniform plexuses to the lung was the cause of postoperative pneumonias following the Bassini inguinal hernia procedure. Kelling considered that the great morbidity and mortality of postoperative pneumonia after abdominal operations for carcinoma of the stomach were due to the septic nature of the embolism in these cases. Rupp found at autopsy in 13,000 postoperative cases 5 per cent having demonstrable emboli and infarctions in the lungs. Cutler and Morton in 1917



of the lung rapidly ensues. Sante proposed this mode of treatment, which in several instances has proven successful. It is easy to understand how exudate flowing to dependent parts comes in contact with healthy bronchi and causes a spell of coughing which disrupts the obstructing column of mucus and transforms a complete obstruction into an incomplete one. This process in the mucous column is probably aided by a deep inspiration which follows a cough, because the forceful ingress of respiratory air into the bronchus could thus also create an airway by breaking up the column of mucus. Aeration of the affected lung would thus be initiated. But I do not see the mechanism by which the simple change of the position of the patient could abolish a bronchoconstrictor or a vasodilator reflex, nor can I understand how a reflex phenomenon would require so many hours to be established.

To the procedure advised by Sante can be compared the method used by Boulan and Cheret for prevention of atelectasis. They claim that by placing the patient in slight Trendelenburg position they avoided the complication. This was proved not only clinically but even by roentgenographic examination, the bases remaining clear and well aerated, whereas dark spots or massive opacity appeared in patients left in horizontal dorsal decubitus.

From the foregoing considerations it can be reasonably concluded that the so called vasomotor reflex has no physiological or clinical foundation and cannot be considered as a cause of atelectasis.

#### COMMENT ON THE THEORY OF BRONCHIAL OBSTRUCTION

The fact that complete bronchial obstruction is followed by atelectasis has already received definite clinical and experimental confirmation, and for the reasons developed above I consider *bronchial obstruction as the only determining cause of the disease*. The difficulties that have stood in the way of determining the etiology and mechanism of atelectasis have been due, I believe to the failure to distinguish between the determining cause and the contributing causes. The

theory of bronchial obstruction applied both to postoperative atelectasis and pneumonia throws a new light on the etiology of both diseases and dispels the cloud hanging over their manner of production. This theory will be thoroughly discussed in dealing with the etiology of postoperative pneumonitis.

#### ETIOLOGY OF POSTOPERATIVE PNEUMONITIS

The term "pneumonitis" is purposely used here instead of "pneumonia" because in this group, besides well defined lobar pneumonias, we find a great number of transitory forms bronchitides with areas of consolidation, bronchopneumonias with atypical evolution and symptoms and pneumonias with confused symptomatology which may be difficult if not impossible to differentiate. They form a group of postoperative pulmonary complications which still puzzle the internists and surgeons. Their etiology and pathogenesis have been, and still are, subjects of intense research and discussion.

Their importance has been recognized only since the advent of the aseptic era. With the popularization of aseptic methods and general narcosis it was recognized that in the absence of local infection the great majority of postoperative elevations of temperature were due to inflammatory conditions of the lung. At first it was believed that general narcosis particularly with ether was the cause of these pulmonary complications, Mikulicz, Poppert and Czerny in Germany favored this view which was supported by experimental work of Poppert who showed that ether could produce transudation and oedema in the lung and by the work of Snell who asserted that ether vapor diminishes or abolishes the bactericidal properties of the lung. Lichtenberg created the special term 'Narcoepneumonie' for indicating this type of complication.

After the introduction of scopolamine morphine anaesthesia and more particularly of local regional and spinal analgesia surgeons were much alarmed on finding no reduction in the incidence or severity of postoperative pneumonitis. And although Neuber, Eiselsberg, Kummel and others had the impression that with these anaesthetics

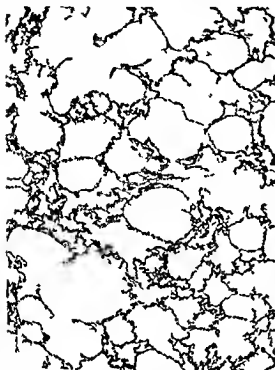


Fig. 6 Dog 82 Photomicrograph of a section of lung injected with India ink—Ringer solution. Section is not stained. The capillaries are perfectly injected. Notice the size of the alveoli outlined by the capillaries. Section taken from the healthy non atelectatic lung.

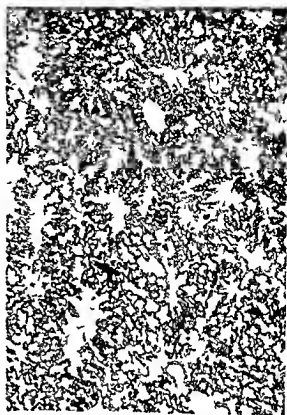


Fig. 7 Dog 82 Atelectasis. India ink. Ringer solution injected into the jugular vein. Section of a portion of the atelectatic lung not completely apneumatur. Notice the collapse of the alveoli, shrunken capillaries but still permeable. Dilated vessels (precapillary arterioles) make their appearance.

temperature, without any physical signs until the second or third day after the onset. At this time there develops the characteristic friction rub and non productive cough or with sputum more or less tinged with bright or dark red blood. Following this after the second or third day the condition gradually improves. In the great majority of cases the physical signs are friction rub which is the most reliable symptom present in about 50 per cent of these cases and often impairment of the percussion note. In postoperative pneumonitis on the other hand the onset is within 12 to 24 hours after operation is accompanied by cough, dyspnea, often cyanosis, as a rule a rise of temperature, and absence of friction rub, furthermore, the physical signs of consolidation are never absent. Very often the patient gives a history of "previous cold" before operation. The differences between this syndrome and infarction are so marked and so characteristic

that a careful examination of the patient must establish the diagnosis. Cutler and Hunt (31) make this distinction themselves by separating the cases of infarction from other postoperative complications, although I believe that their two cases of postoperative pleurisy seem to be clear cut cases of "minor embolism". The cases of these authors described as pneumonia bronchopneumonia, and bronchitis are I believe, all cases of postoperative bronchitis with atelectatic consolidation. Cutler and Hunt (31) themselves admit this point by stating that the "dividing line between pneumonia bronchopneumonia, and bronchitis is not always clear", out of 55 cases of postoperative pulmonary complications of these authors, 42 are called bronchitis, bronchopneumonia, and pneumonia. No one

and Cutler and Hunt in 1920, in two thorough papers, tried to prove that almost all postoperative complications of the lung were due to embolism. The emboli, according to these authors, are formed in the operative field and from there are carried to the lungs "both by blood vessels and lymphatics." They explain the great number of pulmonary complications after operations upon the upper abdomen by the ease of formation of thrombi in that region because "laparotomy exposes surfaces incised in the outer world and evaporation and chilling take place easily." Furthermore, they believe that thrombi thus formed are easily mobilized and "set free because of the mobility of the structures of the epigastrium and the easy path way to the lung and pleura from the upper abdomen both by the blood vessels and the lymphatics." They quote the experiments of Sabin demonstrating the facility with which lymphatic channels may carry sepsis or emboli from the epigastrium. According to these authors the small thrombi thus formed would be fixed in the lung, particularly in the congested or hypostatic areas of the organ.

Before any discussion of the embolic theory, it will be useful to review our knowledge on pulmonary embolism. Wharton and Pierson in their remarkable work on "Minor Forms of Pulmonary Embolism" state that the clinical aspect of embolism will depend upon four factors: the size of the embolus, the condition of the pulmonary circulation, the presence or absence of infection either in the lungs or the embolus, and the position of the artery which was occluded.

We are not interested here with the large emboli which cause immediate death—*la mort sans phrases* of the French authors—or with the medium size emboli which produce a typical infarction. The emboli which are meant by the supporters of this theory as etiological factors in the production of pneumonia or atelectasis are the *minor emboli*.

Let us see now in review the pathological physiology and pathology of the lesions produced in the lung by these "minor emboli." As Karsner and Ash have proved experimentally, the lesions which are produced in the lung by very small emboli vary with the

condition of the circulation in the lung. They will produce significant lesions in the healthy lung "only when they lodge in vessels which are situated along the angular borders of the lobes." On the other hand in the lung with impaired circulation and vascular "stasis" emboli of the same size produce *infarcts* no matter where they lodge, and after 24 hours they produce the complete pathological picture of *infarction* showing hemorrhagic consolidation, pleurisy, and focal necrosis. In normal lungs, the lesions reach their maximum in 24 hours, never pass beyond the state of partial hemorrhagic consolidation, do not develop focal necrosis or pleurisy, and resolution is prompt. Very often minor emboli pass through the lung without giving rise to any lesions or symptoms exactly as happens in experimental embolism in dogs in which even large sized aseptic thrombi introduced into the jugular generally produce no lesion. It is known how difficult it is to produce embolic lesions of the lung in these animals with small or even good sized aseptic and often even with septic blood clots.

In the congested lung in the human, minor emboli according to their nature may produce aseptic or septic lesions. In the former, the pathology will be exactly the same as in infarctions, in the latter, suppuration with septic necrosis may follow. This pathology is very different from that of postoperative pneumonia. Whipple has given an excellent description of the latter and rightly compared it to the mild form of medical pneumonia, known as *maladie de W. Osier*, so well described by Carnere. Maurice Letulle gives a very good resume and photographs of it in his excellent book *Pathologie du Poumon*. Furthermore, the clinical symptomatology of embolism is characteristic, Wharton and Pierson state that the onset clearly distinguishes this form of pulmonary embolism (minor) from the postoperative inflammatory lesions and it is during the first days of the attack that the diagnosis should be made. Infarction occurs late in convalescence after an uneventful week or two, seldom as early as the third or fourth day. The attack occurs suddenly with pleuritic pain below the scapula, tachypnoea, and slight elevation of



Fig 10 Dog 83 Experimental pneumonia Section of portion of the lung not completely consolidated Alveoli and capillaries shrunken capillaries only slightly impaired Notice the presence of dilated vessels (precapillary arterioles) Compare with Figure 7

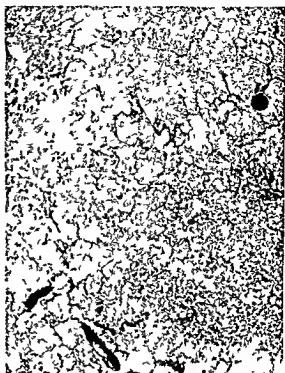


Fig 11 Dog 83 Experimental pneumonia Complete (gray) consolidation Circulation greatly impaired but not completely stopped Notice the great number of dilated vessels Compare with photomicrograph of Dog 8a shown in Figure 8

If we analyze the case histories of post operative pneumonia bronchopneumonia atelectasis and even more or less complicated bronchitis which all form a well defined group designated by Wharton and Pierson as "inflammatory pulmonary complications" we must conclude that they are certainly 'bronchogenous' and not of embolic origin. There are further arguments in favor of this opinion. First why are these lesions exceptional after operation upon the extremities, the head and even the mouth if they are of embolic origin and so frequent after operations upon the abdomen more particularly the upper abdomen? In 97 cases of pneumonia reported by Whipple 88 occurred after laparotomies. Cutler and his collaborators report that the incidence of pneumonia was 1.12 per cent after operations upon different parts of the body other than the abdomen 4.48 per cent after low ab-

dominal operations and 7 per cent and 8 per cent after operations upon the upper abdomen. Mandl's statistics on 1300 cases give 2.7 per cent as the incidence of pneumonia after operations upon the extremities, the head the mouth and the neck, and 10.5 per cent after upper abdominal operations under general anesthesia. Elwyn (46) reports on 0.7 per cent incidence after operation upon the extremities head, mouth, and neck, 6.29 per cent incidence after abdominal operations and 13.8 per cent after gastric operations. Head and Powers presented a clear explanation of these clinical facts by showing the variation of vital capacity after operation. They found that the greatest changes were produced in abdominal operations and the reduction was proportionate to the extent of the procedure and the proximity of the operative field to the diaphragm. The majority of authors who deal with post

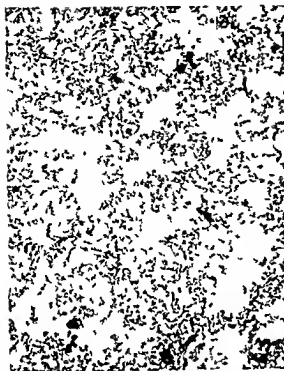


Fig 8 Dog 8. Atelectasis. India ink Ringer solution injection through the jugular vein. Specimen of completely apneumatic portion of the lung. Notice that capillary circulation is greatly impaired but not completely suppressed. Dilated vessels (precapillary arterioles) are still more visible than in Figure 7 (Figures 6, 7 and 8 are taken under some enlargement.)



Fig 9 Dog 8. Experimental pneumonia. India ink Ringer solution injection through jugular vein. Section from healthy non-consolidated lung. The capillaries well injected with the patent alveoli. Notice their size for comparison with Figures 10 and 11.

of these cases for the reasons given seems to be secondary to emboli; a careful study of the histories of these cases can leave no doubt about this point. I feel convinced that this fact would have been more apparent had the authors recorded their radiographic findings and the bacteriological examinations of the sputum, particularly for pneumococcus. In order to illustrate this statement I give here the histories of two of their cases. The first is diagnosed as pneumonia, the second bronchopneumonia.

I, a male 29 years of age with left nephroptosis, lungs negative before operation. Operation for partial decapsulation and nephropexy were done under ether-oxygen anesthesia. Recovery was good. Twenty-four hours later the temperature was 103.6 degrees, pulse 143, respiration 40. Signs of consolidation were present at the right base. The sputum was negative for tubercle bacilli, white

blood cells on tenth day were 1,000. Recovery was by 11th on the eleventh day.

In female 50 years of age the lungs were normal but the heart showed a soft systolic murmur. Under ether anesthesia an operation was performed for an ovarian cyst. On the first day after operation there were dullness and bronchial breathing at the right base. The temperature was 101 degrees, pulse 100, respiration 38. Two days later consolidation of the entire back was present. There were rales but no dullness on the left side. The sputum was negative for tubercle bacilli but a great number of diplococci were found. She was discharged against advice.

In both cases the onset was within 4 hours of an aseptic operation. The right base was affected in both, in the second the whole right lung 48 hours after the onset. A roentgenogram in this latter case would probably have revealed the signs of atelectasis. Many diplococci were found in the second case. I do not see how these cases can fit into the symptomatology or pathology of embolism.



Fig. 14. Dog 251. Complete left atelectasis 24 hours after blocking left bronchus with balloon. Notice clear triangular area *T* due to encroachment of normal lung upon affected side and presenting a curious similarity to the venous triangle described by Lord in pneumonia.

monary artery succeeded in producing a gradual shrinkage of the affected portion of the lung with a noticeable displacement of the diaphragm only a week after and without infarction. Llwyn (46) also discards embolism as a factor in the production either of atelectasis or of postoperative pneumonia. He says that occasionally he has observed cases of pulmonary infarction following operation

but they were definitely diagnosed as such. Among his 89 cases of postoperative pneumonia none could definitely be said to have been caused by embolism from the operative field. Wharton and Pierson protest against the assertion made by authors who consider that the cause of any or almost any postoperative pneumonia is due to 'showers of minor emboli' and insist upon the fact that 'it is as a rule possible to establish a diag-



Fig. 15. Dog, P 27. Left lobar pneumonia 22 hours after insufflation of 1 cubic centimeter of concentrated culture into left bronchus. Notice the clear area at the left base described under Figure 2.

nosis between embolic lesions and inflammatory pneumonia.

It is not necessary to give further quotations and arguments against the embolic theory. I firmly believe that minor embolism as an etiological factor in postoperative pneumonitis cannot be admitted. It was necessary to insist upon this point in detail because in my opinion the embolic theory should be definitely discarded in order to clear the way for a better understanding of the etiology, nature and treatment of postoperative atelectasis and pneumonitis. In this way only can we avoid unwarranted conclusions concerning the treatment of pneumonitis and atelectasis.

It is not deemed necessary to discuss the opinions that chilling or irritation of the bronchial mucosa by anesthetics can by them



Fig. 12. Dog B 47. Twenty four hours after blocking the right bronchus. Complete right atelectasis. Occluding balloon filled up with sodium bromide solution is clearly visible in right bronchus.

4



Fig. 13. Dog B 5. Right lobar pneumonia 24 hours after insufflation of 10 cubic centimeters of the pneumococcus type 1 culture into the right bronchus. Notice the displacement of the heart to the right and the marked elevation of the diaphragm on the right. The same results were obtained when 1 cubic centimeter of concentrated culture was used.

operative pneumonitis or atelectasis are not in favor of the embolic theory for either of them. Henle, in 52 autopsies in a series of 143 surgical pneumonias found only 5 cases of infarction. A. C. Whipple in 7 autopsies of 25 fatal cases of postoperative pneumonitis found no embolism. Furthermore in cases in which pneumonia or atelectasis and embolism existed together it was possible clearly to distinguish one lesion from the other. Churchill reports a case of embolism complicated by atelectasis in which the embolism (sharp pain, rise of temperature, loud crunching friction rub at the right base, blood streaked sputum) was followed after 4 days by signs of atelectasis. This case shows according to Churchill that "even when atelectasis accidentally follows embolism, the two conditions are distinct and can be readily recognized." Conversely, embolism may com-

plicate atelectasis as in Case 5 of Jackson and Lee. A colored man with primary carcinoma of the esophagus and extensive metastasis in the liver died suddenly after a sharp rise of temperature. At autopsy the findings were "a fresh wedge shaped hemorrhagic infarct in the left lung and complete atelectasis of the right lower lobe." It might be objected that the above facts concern atelectasis and not pneumonia. I shall answer this objection in the next part of this paper where atelectasis and pneumonia will be compared. However in closing the subject of possible embolic origin of atelectasis I quote Churchill who aptly remarked: "We see no mechanism whereby an embolus can produce pulmonary collapse. Karshner and Ash have not been able to produce immediate deflation of the lung in minor embolism of this organ. Schlaepfer by ligating a branch of the pul-



Fig 17. Right pneumonia in human (lower and middle lobes). Notice the displacement of trachea and heart to the right and the elevation of the right diaphragm. Compare with Figure 16.



Fig 18. Case 100300 New York Hospital. Postoperative massive atelectasis left side.

common in both. It is difficult in their initial periods to distinguish atelectasis from pneumonia or even from bronchitis. As proof I quote the description of postoperative bronchitis given by Cutler and Hunt (32 p. 23): 'The onset of bronchitis is accompanied by cyanosis, excessive perspiration, the chest is often full of moist rales. It starts always within 48 hours after operation and subsides usually by lysis within 3 days to a week.' Cough is not a constant symptom in atelectasis and pneumonia. In a footnote on F. G. Blake's article on pneumonia in which it is said: 'Cough is not frequent in the earlier stages of pneumonia.' Blumer remarks: 'Turning the patient on the side with the affected side upward so frequently causes cough that I regard it as a diagnostic sign of some importance' (page 9). Is it not common knowledge that exactly the same thing happens in atelectasis? On this latter fact L. Sante based the treatment of rolling the patient back and forth.

*Evolution.* This is very similar in both diseases and lasts from 2 to 13 days, ending



Fig 19. Case 60744 New York Hospital. Left lower lobe pneumonia from the Medical Ward. Notice displacement of the heart and trachea to the left. Compare with Figure 18.





FIG. 16 Case 73814 New York Hospital Postoperative massive atelectasis right side. Note dense opaque shadow which completely obscures right chest. Note marked displacement of trachea to right and pulling over of heart shadow to right.

selves produce postoperative pneumonitis. As to the theories of *passive* or *active congestion* as principal causes the same question arises namely what is the mechanism of production of postoperative pneumonitis in these conditions? A study of the similarities between atelectasis and pneumonia will help us, I believe, to give a satisfactory solution of the problem of their production.

#### SIMILARITIES BETWEEN POSTOPERATIVE BRONCHITIS, ATELECTASIS, AND PNEUMONITIS

The kinship between these complications—bronchitis, atelectasis and pneumonitis—more or less apparent when we study them clinically becomes striking when we investigate them experimentally. As Coryllos and Birnbaum have shown (27) it is impossible in a roentgenogram of a dog's chest to make a differential diagnosis between experimental pneumococcic lobar pneumonia and massive atelectasis. Figures 12, 13, 14 and 15 clearly prove this fact.

There are so many similarities between postoperative bronchitis, atelectasis and pneumonitis that they cannot and must not

be considered as coincidences, they require a more careful analysis and investigation than has formerly been given them.

The similarities are *clinical*, *pathological*, and *etiological*.

#### CLINICAL

Atelectasis and pneumonitis appear within 24 to 48 hours after operations performed particularly upon the abdomen. In the literature the statistics on postoperative atelectasis of W. Pasteur, Armstrong, Scamiger, Churchill, Scott (124, 125), Holmes, Mastics et al. (90), Jackson (69), Lee, Leopold (81, 82), Elwyn, Hirschbrock, Rigler, Mason, H. Santee, Bergamini and Shepard, Ball, Roland and Cheret, etc., clearly show a great predominance of abdominal operations as forerunners of the disease. In 134 cases of atelectasis compiled from the literature, the following incidence was found:

	Cases
Appendectomies—septic or aseptic	4
Hernias simple or strangulated inguinal or ventral	36
Gastric or duodenal procedures and exploratory	6
Laparotomies	17
Cholecystectomies	17
Hysterectomies or salpingectomies and caesarean sections	17
Thyroidectomies	3
Kidney operations	3
Rectal operations	2
Perineal operation	1
Injury of hip	1
Fracture of cervical spine	1
Fracture of pelvis	1
Tumor of thigh	1
Axillary abscess with streptococcus bacteremia	1
Total	134

It should be borne in mind that these statistics are incomplete since the diagnosis of atelectasis is still relatively infrequently made in the United States and even less frequently at Continental medical centers. It is interesting in this regard to quote Pasteur (101) who in reporting his statistics from the surgical service in Middlesex Hospital, says: "Mr. Simmonds (the surgeon) considers from the description given in the notes that 20 cases regarded as pneumonia were probably examples of massive collapse."

**The onset.** Within 24 to 48 hours after operation pain and dyspnea, a variable degree of cyanosis and elevation of temperature may appear. The above signs and symptoms are

V S A woman 20 years old gave no history of past or present respiratory infection, and a preoperative roentgenogram of her chest was negative. A left oophorectomy and right salpingo oophorectomy with routine appendectomy were performed for bilateral, multilocular adenocystomata. Ether anesthesia with gas induction was employed. During the operation the respirations were rapid, with excessive mucus. On the evening of the following day there was a sudden rise of temperature, pulse and respiration accompanied by dyspnea. Examination showed a limited excursion of the right chest with flatness to percussion and diminished breath sounds below the clavicle. The heart was displaced to the right. The next day the patient was improved and she raised a small amount of purulent sputum containing pneumococci and streptococci. Sonorous râles were present throughout the lungs and below the angle of the scapula. On the right there were bronchial breathing, argophony, increased voice sounds and normal tactile fremitus. A roentgenogram taken 2 days after the operation showed increased density of the right chest especially at the base and displacement of the heart and mediastinum.

Is not this case diagnosed "atelectasis," strikingly similar to an atypical case of pneumonia of the right base? Auscultatory symptoms of consolidation and pneumococci in the sputum were present. In other cases of the same author, pneumococci types 3 and 4 were found in pure culture. The sign on which the differential diagnosis between atelectasis and pneumonia was based was displacement of the heart and trachea to the affected side. But it has already been shown that this sign may as well be present in pneumonia, particularly in children and it is always present in experimental pneumonia in the dog (Figs 13, 15). At the onset of atelectasis, says L. Sante (119), the condition may resemble lobar pneumonia and "if alveolar absorption takes place rapidly and there is still some obstruction of the bronchi by secretion, displacement of the trachea may be present in pneumonia as a manifestation of atelectasis, under these circumstances *lobar pneumonia* in the resolving stage *cannot be differentiated from massive collapse*." Conversely when the upper lobe alone is atelectatic displacement of the heart may be negligible and deviation of the trachea the only symptom. Pratt and Bushnell say (107 p. 139) "While the pneumonic process is still localized, the loss of expansibility of

the affected lobe tends to produce a displacement of the heart toward the lesion. Later in the disease when the hepatized lobe has increased in volume, it tends to push the heart away." However, they add, "such displacement is usually not well marked."

E. Jachet found in roentgenographic examinations that "massive atelectasis caused practically the same density of a lobe or the entire side of the chest as that seen in lobar pneumonia" but he adds, "it may be distinguished from the latter by the displacement of the heart to the affected side and elevation of the diaphragm." L. Sante expresses a similar opinion. S. Leopold (82), discussing the differential diagnosis between pneumonia and atelectasis, says, "This is the condition with which massive pulmonary collapse is most frequently confused, as evidenced by the experience of numerous observers who, after having their attention attracted to massive collapse have gone back over their records of 'postoperative pneumonia' and discovered that in some cases the symptoms, the physical findings, and roentgen ray studies, were typical of massive collapse. The symptoms pulmonary physical findings, and leucocytosis may be regarded for clinical purposes as so similar that on these findings a differential diagnosis is impossible. The displacement of the heart and mediastinal structure towards the affected side in case of massive collapse is the diagnostic point of differentiation." The massive degree of involvement in cases of collapse, the absence of the toxicity one would expect in lobar pneumonia particularly in the postoperative type, are of some importance when these cases are considered as a group but *could not be very helpful in an individual case*."

It would seem from the above that the only diagnostic physical sign between these two postoperative complications atelectasis and pneumonia, is on last analysis the displacement of the heart and the trachea to, and elevation of the diaphragm on the affected side in atelectasis. But even this sign is not at all pathognomonic. In several instances "inexplicable displacement of the mediastinum and its contents to the affected side and elevation of the diaphragm" have



Fig. 20. Right lobar pneumonia in monkey; a lung. Posterior view (After Blake and Cecil)



Fig. 1. Experimental pneumococcal pneumonia in dog. Left lung consolidated. Lung extracted after clamping the trachea (before the opening of the chest). Notice the difference in the size between the consolidated airless dark colored left lung and the light colored normal right lung.

by crisis or lysis. But there are even more striking similarities. The lobar localization in both atelectasis and pneumonia was the one which impressed the writer the most at the beginning of his experimental investigation on atelectasis. Why does this lobar distribution occur in atelectasis and in postoperative pneumonia as well as in medical lobar pneumonia? Little thought about this point and still less explanation of it have so far been given. We shall return to this question later.

The physical signs by percussion and auscultation are no less impressive by their similarities. At the beginning of a pneumonia there are dullness with slight tympanic resonance, and absence of breath sounds. In lobar atelectasis we have these signs throughout the disease. Likewise fine rales, bronchial breathing, and increased fremitus are apt to develop or be absent both in postoperative pneumonia and postoperative atelectasis. J. R. Bradford (13)<sup>1</sup> divides the physical signs of atelectasis into three periods: (1) signs of retraction and immobility of the affected side, weakness or absence of breath sounds,

and displacement of the heart often extreme, (2) weakness of the breath sounds has been replaced by loud tubular or amphoric breathing together with increased vocal fremitus, loud bronchophony, pectoriloquy, and transmitted spoken voice. (3) stage when the lung is expanding abundant rales may be present over the area where tubular breathing is marked.

The same author considers atelectasis as "a possibility in pneumonia" and reports the autopsy of a case in which there was "a pneumonia in the upper left lobe and atelectasis in the lower", and further he states that pneumonia may complicate atelectasis and then is limited to the affected lobe." Norris and Landis speak of massive atelectasis as a complication of pneumonia and Reynolds (1871) describing consolidation in newborn children insists on the point that the distribution of the affected lobules is in direct relation to the condition of the corresponding bronchial tubes. It is often impossible from the case histories to differentiate atelectasis from pneumonia. For illustration of the above statements, I give the history of a case called "atelectasis" (Case 1 Churchill 21)

TABLE I—STATISTICS OF MASTICS AND OTHERS

Lobe	Number	Per cent
Right lower	5	50
Left lower	10	20
Right upper	2	4
Left upper	3	6
Right middle and lower	1	14
Right upper and lower	2	4
Right upper and both lowers	1	2

sinks in water. In both pneumococcus particularly group 4, is almost constantly present, and it is curious that this fact has not attracted more attention. Whipple has shown that in postoperative pneumonia "sputum as a rule, is a yellow mucus and usually shows pneumococcus, group 4 in both the pre operative and postoperative specimens. Cleveland expresses the same opinion. In atelectasis the sputum presents the same characteristics.

Churchill reports 9 cases of atelectasis and in practically every one in which an examination of the sputum was made, pneumococcus group 4, was found. In one case pneumococcus, type 3 was present—an unusual finding in postoperative pneumonia.

In the case of Hearn and Clerf which was bronchoscoped seven times within 36 days the secretion contained gram positive diplococci. In the cases of Lee, Tucker and Clerf the mucous secretion obtained by bronchial aspiration contained pneumococci, and when injected into the bronchus of an anesthetized dog, atelectasis was produced. On the other hand, in cases of medical pneumonia in the human, bronchoscoped in the services of Drs. A. Lambert and I. Conner by Dr. J. D. Hearn and myself, we constantly found the bronchus corresponding to the pneumoniae are occluded with thick exudate as in atelectasis. After bronchoscopic aspiration of a few centimeters of exudate, often a great amount was expectorated by the patients exactly as in cases of atelectasis (24).

Another argument in favor of the identity of these two conditions is the similarity of localization. Table I shows the statistics of Mastics and others in 50 cases of atelectasis.

In Scott's statistics of atelectasis (40 cases) only the side is mentioned the right side was involved in 31 cases, or 78 per cent the left side was involved in 9 cases or 22 per cent.

TABLE II—STATISTICS OF ELWYN

Lobe	Number	Per cent
Right lower	35	55.5
Left lower	17	28
Both lowers	7	11
Right upper	1	1.5
Left upper and left lower	1	1.5
Right upper and both lowers	2	3.5

Table II shows the statistics on postoperative pneumonia of Elwyn (63 cases, following operations performed under local and general anesthesia).

The comparative study of Tables I and II shows clearly the striking similarities between these two conditions, so far as their localization is concerned.

#### ETIOLOGICAL

In order to avoid unnecessary repetition we will merely show that in the great majority of cases the two conditions cannot be differentiated from the etiological standpoint. A number of cases taken from different authors will illustrate this point. The following are two cases of Rigler.

**CASE 4.** Twenty four hours after a bilateral salpingectomy the temperature rose to 100 degrees. The next day it was 101 degrees and patient had a cough was cyanotic and showed signs of consolidation of the right lung. Roentgenograms showed the right lung opaque, mediastinum markedly displaced to the right. On the third day, the temperature rose to 104 degrees with 15,000 white cells. The crisis occurred 10 days after the onset and 2 days later the right lung was clear and the heart in normal position. Two days later symptoms of empyema developed displacing the heart to the left side.

**CASE 5.** Typical right massive atelectasis 24 hours after salpingectomy until third day when rusty sputum appeared with distinct signs of consolidation of the right upper lobe. Roentgenograms showed upper lobe pneumonia with haziness of the medium and lower right lobes. There was a marked displacement of the mediastinum to the right and a very high right diaphragm.

Rigler thinks that in these cases pneumonia complicated atelectasis, that the first was a case of typical atelectasis, but because of the empyema which followed 2 days after crisis Rigler presumes that the elevation of temperature from 101 to 104 degrees on the third day must have been due to the development of pneumonia as a complication. I

been found in pneumonia Thoenes in 1922 reported 11 cases of lobar pneumonia in which roentgen ray examination showed displacement of the heart to the affected side, more particularly in early life St Engel pointed out that elevation of the diaphragm to the affected side in lobar pneumonia is of common occurrence Wallgren insisted upon displacement of the heart toward the affected side in unilateral croupous pneumonia in children Griffith (54) gives the history of a child less than a month old in which the diagnosis between atelectasis and pneumonia was impossible, and he concludes that lobar pneumonia may at times be capable of producing similar, if not perhaps as marked, roentgen ray appearances as seen in massive atelectasis The same author in a more recent paper (1927) reports 40 cases of pneumonia in young children Sixteen among them presented displacement of the heart to the affected side All the authors mentioned explained the displacement by compensatory hyperdistention of the healthy lung with the exception of St Engel, who is the only one to suggest that 'it might be dependent upon a diminution of size of the affected lung caused by a reflex interference with respiration on the side'

Among roentgen ray plates of pneumonia at the New York Hospital obtained through the kindness of Dr W W Belden<sup>1</sup> were found a great number showing displacement of the heart and trachea to the affected side and in almost all, elevation of the diaphragm was found (Figs 16, 17 18 19) In a series of slides of Dr T C Roper<sup>1</sup> (prepared in 1915) dealing with evolution of lobar pneumonia in children, not only did I find displacement of the heart and elevation of the diaphragm to the affected side in practically every one of these, but, furthermore, there was a characteristic return of the structures to their normal sites as the diseased lung healed The roentgenograms given by O T Pickhardt in his paper on "Unresolved Pneumonia" are also of interest in this respect One can clearly see in this author's illustrations displacement of the heart to the affected side and homolateral elevation of the diaphragm (Figs 2

4, 6, and 8) with the return of these structures to normal position after healing of the lesion (Figs 3, 5, 6 13 in the paper of this author)

There is no doubt that displacement is not due to a primary compensatory emphysema or overdistention of the healthy lung compressing the consolidated lung A hyperdistention of the healthy lung certainly exists but this is secondary and due to the decrease in size of the affected lung The view that the pneumonic lung is decreased in size, contrary to what is generally believed and taught in textbooks (Fig 10), is supported by the fact that in uncomplicated lobar pneumonia there is never displacement of the heart toward the healthy side nor flattening of the diaphragm findings which one should expect if the diseased lung were really enlarged The idea that the pneumonic lung is larger has been perpetuated from one textbook to another, and from generation to generation, because the lungs are examined on the autopsy table after their extraction from the thoracic cavity and without the trachea having been previously clamped It is natural that under such conditions with the negative intrapleural pressure eliminated the healthy lung collapses readily whereas the consolidated lung cannot It is easy to verify this fact by removing the lungs of a person shortly after death from pneumonia, after having previously completely occluded the trachea with clamps One should carefully avoid undue manipulation of the healthy lung and proceed with dispatch because the air diffuses through the surface of a healthy lung very rapidly as Lichtheim has shown Figure 27 gives the relative sizes of consolidated and healthy lungs in experimental pneumonia in the dog

Thus the last and only remaining differential or 'pathognomonic' sign between atelectasis and pneumonia would seem to be neither pathognomonic nor characteristic of atelectasis as is commonly supposed

#### PATHOLOGICAL

In the pathological examination we find marked similarities in pneumonia and atelectasis In both conditions the lung is airless, apneumatic consolidated fleshy friable, and

<sup>1</sup>Personal communication

the ninth day after operation bronchial breathing was heard over the lower half of the right lower lobe. From this day on the breath sounds gradually became more distinct over the remainder of the lung and the bronchial breathing over the right base gradually diminished. The heart came back to its normal position after some time.

Elwyn (46) considers the above cases as of "uncommon occurrence." I do not agree with this opinion and consider these cases much more frequent than generally believed. If they are not reported more often it is because special attention had not been given to them. In these two cases of postoperative massive atelectasis, the middle and lower lobes were involved because of the occlusion of the right bronchus below the level of the upper bronchus, then because of the dislodgement of the "plug" the middle and lower lobes became aerated, with the exception of that portion of the latter dependent upon the first posterior bronchus which remained occluded. It is of no little importance that the persistence of the occlusion was due to increased virulence of the pneumococci; it is known that viscosity of the exudate and amount of fibrin depend upon the degree of virulence of the pneumococci. The simple atelectasis in that pulmonary territory corresponding to the first posterior bronchus was transformed into lobar pneumonia, or more exactly into a pneumococcal atelectasis because pneumococcal cellulitis developed. This sequence of phenomena was repeated in the second case of Elwyn (46) in exactly the same way.

If in the intrabronchial exudate instead of pneumococcus of low virulence staphylococci, streptococci, or anaerobes were present a suppuration or even gangrene of the lung might have ensued. A good illustration of this is offered by the following case of Churchill and Holmes.

In a female aged 31 years a curettage suspension of the uterus, ovariectomy and appendectomy were done under ether anesthesia. Immediately after there was dry cough and later green sputum appeared. About a month later the sputum became foul. Fourteen days after the onset she was admitted to the Massachusetts General Hospital presenting a dullness at the base of the right lung below the scapula, diminution of vocal and tactile fremitus and of breath sounds. A few moist rales

were present. The sputum was foul, about 7 ounces per day. Bacterial examination showed influenza bacilli and streptococci. Roentgenograms showed the mediastinum displaced to the right and the movements of the diaphragm markedly limited on the right side.

These case histories illustrate the striking similarities between postoperative atelectasis and postoperative pneumonia. They demonstrate the paramount importance in the various suppurations of the lung, of the obstruction of a bronchus with consequent suppression of the normal drainage of the corresponding bronchial tree; such drainage is the natural mechanism for self defense and sterilization of the lung.

### THEORY

From experimental and clinical investigation, the conclusion is drawn that there are no differences between postoperative pneumonia and postoperative atelectasis other than those due to the type and the virulence of the micro-organisms infecting the occluding bronchial mucus. I am convinced that the determining factor in the production of this condition is the more or less temporary "plugging" of a bronchus by mucus, which is followed by the absorption of the alveolar air and atelectasis of the corresponding lung. However the term "plugged" must not be taken literally—no more so than the term "corking" used by Chevalier Jackson (71). The obstruction of a lung does not depend only upon the consistency and viscosity of the bronchial exudate. It depends as well upon the expelling force of the lung. Very viscid and tenacious mucus may not be able to obstruct a lung which maintains unimpaired its means of defense, namely coughing, respiratory movements and activity of its ciliated epithelium. The cilia probably help break up the column of mucus and cough expels this mucus from the bronchus. On the contrary, very thin mucus may be able to obstruct a bronchus when the lungs are at a disadvantage—as they often are after operations because of suppression of the cough reflex by narcotics, pain, posture, splinting of the thorax, paralysis of the respiratory muscles or because of general weakness in

cannot agree with Rigler because there are a great number of cases of atelectasis with a temperature of 104 degrees, and more with a 15,000 white cell count. Shall we consider these cases as atelectasis or as pneumonia? We know that in almost every case of atelectasis, pneumococcus is present in the bronchial exudate, and often in pure culture. The fact that the development of pneumococcic empyema is unusual in atelectasis seems surprising and this is due, I believe, to the low virulence of the infecting agent and to the rapid liberation of the bronchi. In Case 5 of Rigler we have the same phenomenon as in the cases of Elwyn (46) given later. In this patient we have a clear cut case of postoperative atelectasis which because of the presence of virulent pneumococci in the exudate occluding the bronchus was transformed into lobar pneumonia. N. B. Gwyn, in 1926, reported cases of atelectasis complicating pneumonia.

**CASE 1.** A woman 60 years old with lobar pneumonia had complete consolidation of the right lobe. About the fifth day of the disease she was suddenly seized with dyspnea, prostration and cyanosis and the upper lobe which was formerly overexpanded was now apparently solid. The physical signs were those of a newly consolidated area, but the heart was displaced to the right beating to the right border of the sternum. Clearing began in 6 hours and the heart returned to its normal position in 4 days.

**CASE 2.** Patient entered with signs of a small area of consolidation at the left base. During the night there occurred an attack of dyspnea and in the morning the involvement seemed more extensive. There was a marked displacement of the heart, the apex was felt in the left axillary line, the left chest was flatter than the right. Roentgenograms showed a typical picture of atelectasis. Healing occurred after a week with return of the mediastinum to its normal position.

**CASE 3.** A boy of 6 had pneumonia in the left lower lobe. Involvement of the left apex occurred at the end of 2 weeks without added distress. The chest was completely solid, sounds were tubular but varying. From day to day the presence or absence of rales was noted. The left chest was sunken and motionless. The right chest was overdistended and clear. The heart was displaced to the left and upward. The left diaphragm was elevated to the level of the third rib in front. The left lung was very solid behind, puncture gave no fluid. Three days later examination showed that resonance was appearing in the midback and that the heart was

lower in the chest. Roentgen ray picture revealed the heart in normal position, diaphragm lower.

In these cases atelectasis complicated an already existing pneumonia. How would it be possible to explain the pathogenesis of atelectasis in these cases by vasomotor or by reflex nervous obstruction of the bronchioles of the affected lobe or by embolism? I believe that in these cases a temporary obstruction of another bronchus occurred which produced an atelectasis of the lobe corresponding to that bronchus. If, in these cases the bronchial obstruction had been of longer duration and the pneumococcus virulent enough to produce pulmonary cellulitis instead of simple apneumotosis we would have had an ordinary extension of the pneumonic process to the newly affected lobe. Here on the contrary, has happened exactly what occurs in postoperative atelectasis where, although pneumococcus is present, lobar pneumonia does not develop, because of the rapid liberation of the bronchus from the mucous "plug." This same mechanism can easily explain the production of the so called abortive forms of pneumonia. This opinion seems corroborated by the fact that pneumonia can complicate atelectasis as is shown in the following cases of Elwyn (46).

**CASE 1.** The day after a left herniotomy the patient developed a cough and had pain in the right chest. Breath sounds were absent anteriorly and over the right chest and below the third rib. There was marked dullness and diminished breath sounds below the angle of the scapula posteriorly. The heart was displaced to the right. These symptoms persisted for 4 days when dullness, bronchial breathing and rales over the lower half of the right lower lobe appeared. The roentgenograms showed a dense shadow over the lower half of the right lung and the heart and the trachea and mediastinum displaced to the right.

**CASE 2.** Colostomy was done for carcinoma of the ileocecal junction on June 20. A roentgenogram taken previous to the operation showed the chest to be normal. The same day the temperature rose to 102 degrees. The day following the operation a physical examination showed breath sounds markedly diminished over the lower two thirds of the right lung anteriorly and posteriorly. On percussion there was a tympanic note in front and dullness from the spine of the scapula to the base posteriorly. Roentgenograms on the third day showed heart and trachea displaced to the right and a very high diaphragm on the same side. On

many cases following abdominal operations, we were able to observe signs of consolidation over a part of the lobe, which disappeared in 20 to 48 hours, often during the examination, after a fit of coughing. In some of these cases a roentgen ray examination showed a high position of the diaphragm on the affected side." He considers that atelectatic areas are present most often after abdominal operations and that infection spreads to them due to a bronchitis existing before the operation or caused by the anæsthetic.

It is interesting here to quote Meltzer, who studied the pathogenesis of experimental pneumonia in the dog. He suggests that "in the human a previous cold may furnish a mucus secretion which might occlude several small bronchi and thus prepare a favorable ground for the pneumococci which secondarily infect this mucus secretion, under these circumstances, pneumococci develop rapidly and invade the surrounding tissues. Lee (1924) believed that collapse of the lung in varying degree is a constant phenomenon in any operative procedure and in traumatic or inflammatory injury of the heart and bronchi.

Czerny (34), in 1905, considered as the cause of postoperative pneumonia "retention of bronchial exudate in the bronchi" and created the term "retention pneumonia." The description he gives of it is absolutely identical with that found in "drowned lung" of Leopold (81) in atelectasis.

The relation between pneumonia and atelectasis was seen by these authors, but the nature and importance of this relation had not been grasped. The possibility of secondary infection of an atelectasis, says Ilwyn (46), "does not solve the question, but merely puts it back a step further. The question is how does the collapse of the lung arise?" Scott and Joelson (1927) in a rather prophetic statement, have said "An explanation of the origin of postoperative massive atelectasis will undoubtedly do far more than solve this clinical mystery since it may prove to be a most important step in reducing the incidence of these fatal postoperative pulmonary complications now classified as pneumonia." But it is really astonishing

that the man who clinically discovered massive atelectasis, W. Pasteur (101), had the clearest foresight as to the significance of atelectasis. "I feel sure," he wrote in 1910, "that when true history of postoperative lung complications comes to be written, active collapse will occupy an important position among the determining causes."

I consider that atelectasis in its different forms multilobar (massive), lobar or lobular (patchy) due to pre operative or postoperative bronchitis, is not only the forerunner of postoperative pneumonia or bronchopneumonia, but that it is an initial and integral part of the disease syndrome. It is a manifestation of the role bronchial obstruction plays in the causation of pulmonary complications. Bronchial obstruction is the starting point of pneumonitis, lobar or lobular, and most probably also of abscess and gangrene as well. The particular condition arising will depend upon the infecting agents. So long as the bronchi are open and their drainage insured, the lung maintains asepsis by the mechanical means at its disposal—evaporation, expectoration, activity of the ciliary epithelium, and the antiseptic power of the mucus (Arlong), but when obstruction occurs the fate of the parenchyma depends upon the microbes present in the occluding mucus. If they are of low virulence, there will be a slight degree of inflammation, a slight amount of exudate, and little or no fibrin. The air will be absorbed, and the walls of the alveoli will collapse completely, reducing to a minimum the size of the lung with marked displacement of the mediastinum, heart, and trachea and with elevation of the diaphragm. If the mucus be infected with more virulent pneumococci, then a condition called postoperative pneumonia (postoperative pneumococcal atelectasis) lobar or lobular, will develop. The amount of exudate will be greater and consequently the decrease in the size of the lung less marked and the displacement of the mediastinum less conspicuous. If pyogenic micro-organisms are present (staphylococcus streptococcus influenza bacilli etc.) abscess may result if the occlusion is sufficiently prolonged. If, finally, virulent anaerobes are present, gangrene may ensue.



wasting illnesses bedridden patients, etc. An example of the possibility of bronchial obstruction by thin mucus is given in the case of Harrington.

A man of 28 years was operated upon for right nephrectomy under ether anesthesia. Twenty four hours later typical atelectasis of the left lung appeared and was complete in 4 hours. The left lung was completely opaque the heart and the trachea displaced to the left and diaphragm visible because of the dense shadow. A bronchoscopic examination was made. Upon the introduction of the tube a thin serous secretion poured out of the trachea the consistency of the fluid was not thick as in the case observed by Tucker. Dyspnea and cyanosis subsided immediately after aspiration of the fluid. A roentgenogram taken 15 minutes after showed the heart in normal position and a marked decrease in the pulmonary density.

*Pneumococcus* is reported practically in every case of atelectasis and postoperative pneumonia in which bacteriological examination has been made. Furthermore, as A. O. Whipple has shown, this *pneumococcus*, group 4 is identical with *pneumococcus* isolated from the mouth of the patients previous to operation. This *pneumococcus* is generally of a low virulence so that the exudate will not be rich in fibrin. Wadsworth has clearly established that the amount of fibrin in the exudate is proportional to the virulence of the organism.

What may be the course of an atelectasis once established? There are various possibilities.

1. During a coughing spell the main column of mucus may be disrupted or expelled and the affected lung is rapidly aerated or there may be a partial expulsion and only partial aeration of the parenchyma. Another coughing spell will evacuate more mucus some bronchi will be freed and so on until the lung is completely aerated. The fact that aeration of the lung proceeds from above downward makes it easy to conceive the "creation of an airway" by disruption of the obstructing mass of mucus and consequent transformation of a complete obstruction into an incomplete one. By a subsequent occlusion of a previously liberated bronchus an already aerated portion may again be obstructed and become atelectatic. This explains the variability of the physical signs

The rapidity of the expulsion of mucus depends not only upon the condition of the patient and the expelling force of his thorax but also upon the amount of fibrin present in the exudate—an amount which we have already said was proportionate to the kind and the virulence of the microbes present. The investigation of Archibald and Brown of cough reflex, and the conclusions drawn by Lee, Tucker, and Clerf concerning the production of bronchial obstruction are of great interest in the elucidation of the mechanism of this obstruction.

2. If the obstruction is prolonged and the virulence of the *pneumococci* sufficient a *pneumococcal* cellulitis (as in medical lobar pneumonia) will follow. This in postoperative cases is generally mild and produces a pneumonia comparable to the mild type of medical pneumonia (called *maladie de Hœlzel*). In this way the condition starts as atelectasis and continues to develop as pneumonia (cases of Elwyn). When the major part of the mucus exudate is expelled and only a few bronchi remain occluded we will have forms similar to those observed by Rigler (Case 5) with *pneumococci* in the occluded area becoming more virulent.

3. If the obstructing mucus is infected with pyogenic organisms, suppuration may follow if the obstruction is prolonged. If anaerobes are present gangrene may ensue. The origin of lung abscesses following tonsillectomies bronchopneumonia or pneumonia are due I believe in the great majority to the same mechanism. The abscesses following delayed or unresolved pneumonias are the most characteristic of this group.

Viewed from this angle the problems of postoperative bronchitis atelectasis and pneumonia are greatly simplified. The relation between them has interested several authors. Elwyn (46) suggested that "the greater number of postoperative pneumonias were due to infection taking place in atelectatic or collapsed areas of the lung. In 194 after a careful study of all operative cases, he says (47) "attention was especially directed toward finding atelectatic areas of the lung in the first few days following the operation. In

to understand that under the combined effect of narcotics, pain, and posture, they are decreased, especially after operation upon the upper abdomen or after thoracic traumatism (J R Bradford) Also, as Head and Powers have shown, the vital capacity decreases considerably after operation on the upper abdomen. For the same reasons the lesion appears within 24 hours after operation and clears up as soon as the means of defense of the lung are recovered.

From these considerations, we can conclude that prevention of postoperative lung complications should be possible if we could prevent the formation of mucous exudate and the decreased ventilation of the lung especially that of the lower lobes. How can this be accomplished? I believe that since the viscosity of exudate is dependent upon the virulence of pneumococcus group 4, every attempt should be made to decrease the virulence of this microbe. Careful pre-operative cleansing of the mouth, a preliminary inspection by the dentist, and a mouth wash with optochin, hydrochloride, 1:500, repeated every 3 or 4 hours will be of great help. Optochin is a powerful and specific bactericidal against pneumococci. The internal use of optochin base has given some encouraging results (Norgrenoth and Levy, A E Wright Baldwin and Rhoades, Walter, Cross). With Dr J Cline on the Second Surgical Division of Bellevue Hospital, I experimented with optochin base by mouth and the hydrochlorate salt by rectum, before and for 24 hours after operation without noticing any marked differences with the cases taken as controls. I shall not insist upon the necessity to postpone if possible operation in the presence of a common cold or of a sinusitis. The importance of these conditions for the development of postoperative pulmonary complications has been sufficiently emphasized (Whipple, Cleveland, Churchill etc).

I should like to lay emphasis upon another therapeutic agent, which seems to me thus far to exert a marked influence in the prevention of postoperative pulmonary complication. This is the use of a mixture of carbon dioxide and oxygen, or even air. It is not necessary to enter here upon the theo-

retical or experimental detail of this important question. The results of the experimental work of Henderson and Haggard, Birnbaum and myself will be given in a paper to appear shortly.<sup>1</sup> Suffice it to say that carbon dioxide seems to act in two ways: first, by producing hyperventilation of the lungs, it prevents the deficiency in respiratory excursion which follows operation especially on the abdomen and thus provides the alveoli with the necessary amount of air for expulsion of intra-bronchial secretion. Second, it appears from our experimental data that carbon dioxide by decreasing the hydrogen ion of the exudate acts upon the pneumococcus to inhibit its growth and probably by favoring the proteolysis of the fibrin in the exudate. Both of these actions have as an effect, besides the decrease in virulence of pneumococci, the liquefaction of the exudate and its easier expulsion. Henderson and Haggard (60) in a preliminary paper insisted upon the importance of the last mechanism. The results obtained by Scott and Cutler (1928), Sixe, Działoszyński (1927), Fischer (1928), and others show the real importance of this method in prevention of postoperative pulmonary complications.

The authors mentioned used the carbon dioxide-oxygen inhalation with the idea of washing out the ether after anesthesia, following the advice of Henderson and Haggard (62, 1921) and the brilliant results obtained by these authors in the resuscitation of carbon monoxide asphyxias (61, 1922) and alcohol intoxications (63, 1924). Henderson and Haggard (60) believed that prevention of lobar pneumonia in cases of carbon monoxide asphyxias by treatment of carbon dioxide inhalation was due to the rapid elimination of carbon monoxide. But they could give no clear explanation of the exact mechanism of this action. The experimental work of Coryllos and Birnbaum (27) brought the solution of this problem by showing the relation existing between atelectasis and pneumonia. Hyperventilation acts in both diseases by relieving the obstruction, aerating the apneumatic lung and above all by re-establishing a free bronchial drainage.

<sup>1</sup>This paper has appeared in Arch Int Med 1930 xlv 72

## TREATMENT

By the theory thus developed, the pathogenesis of pathological postoperative pulmonary conditions can be explained and the foundation laid for a preventive and curative treatment, based upon sound etiological principles. Bronchial obstruction cannot be produced unless two factors are present. The first is a more or less viscid bronchial secretion and the second the inability of the lungs to expel it. This second factor will depend upon the viscosity of the exudate and the degree of impairment of the means of defense of the lung. Consequently, the elimination of all or one of the factors named in this conception be correct, will prevent or cure postoperative complications of the lung (of non-embolic origin). Let us consider each of these factors separately:

1 *Bronchial secretion.* It is known that mucus is abundantly secreted by the innumerable mucous glands of the bronchi (of 1 millimeter diameter and up) as a response to the slightest irritation of the bronchial mucosa, and that it is constantly pushed outward by the ciliary movements. The cilia can propel foreign particles at a rate of 0.5 millimeter per second. Dixon and Inchley described an ingenious apparatus the "cilio-scribe," by which this rate can be measured with precision. Under normal conditions, the amount of mucus secreted is small and the ciliary movement suffices for its elimination. But with the slightest irritation it increases considerably and its contact in increased amounts with the mucosa of the larger bronchi produces cough which contributes to its expulsion. The expelling force of cough is considerable. For this reason, it is almost impossible to obstruct the bronchi of a dog and produce obstructive lesions if the animal is not completely and deeply anesthetized, and this for several hours after the obstruction. For that purpose Coryllos and Birnbaum (25-29), and Lee Clerf and Tucker used amytal (iso amyl ethyl barbituric acid, Lilly) intraperitoneally for anesthesia in their experimental work. Even then cough was often produced when my obstructing balloon was being inflated in the bronchus, and it was necessary to use a small

piano wire spring device in order to avoid expulsion of the balloon. Deep respiration and thorough aeration of the bronchial airways and the alveoli insure against stagnation or accumulation of mucus with possible occlusion of bronchi. The inspiratory dilation of bronchi, the alternating respiratory currents of air, the ciliary movements, and the expulsive powers of coughing are the usual defenses of the lung against infection. To these must be added the antibacterial properties of the bronchial mucus.

But in case of bronchitis there is, besides increased secretion, a number of other modifications, prominent among which are a hyperemia of the mucosa with a more or less marked degree of edema and subsequent narrowing of the lumina of the bronchi. Moreover and this is to my mind the principal factor, bronchial inflammation allows group 4 pneumococci normally present in the mucosa of the mouth and throat to descend the air tract, their presence modifies the nature of the bronchial secretion, which now becomes richer in fibrin and much more viscid. A vicious circle is thus created, the increased viscosity renders expulsion of bronchial secretion more difficult, and its prolonged contact with the mucosa increases the inflammatory reaction of this membrane and consequently the amount of bronchial secretion. The motility of the epithelial cilia becomes more and more impaired. If now the cough reflex decreases in force or ceases altogether if the amplitude of respiration diminishes and if the patient is immobilized in one position it is easy to understand how bronchial obstruction may occur. The mechanism of cough described by Archibald and Brown gives a clear explanation of the production of patchy lobar or massive atelectasis according to whether the obstruction of a small lobar or common bronchus ensues. At the same time it explains how displacement of this mucus can create an airway and result in a temporary or permanent expulsion of the mucus with a temporary or permanent aeration of the involved lung.

2 *Means of defense of the lung.* The means of defense of the lung have already been mentioned. In postoperative cases, it is easy

5 to 10 per cent carbon dioxide and oxygen. If special mixture tubes are not available, a rubber bag is filled with oxygen and carbon dioxide added to it. There is no danger in using mixtures of even 15 per cent carbon dioxide. If a special Henderson and Haggard inhalator (as used by Fire Departments) is available, the valve is fixed at 10 pounds. Immediately after the first few inhalations respiration is modified and respiratory movements become deeper. After a little experience, it is easy to regulate the amount of carbon dioxide and oxygen given, so as to maintain the patient in a condition of deep breathing. It is not necessary to prolong this inhalation over 3 to 5 minutes at a time. Every 2 to 3 hours, when the patient is in the ward, a tube of the mixture or a bag as described above may be used in conjunction with an anaesthesia mask or a nasal catheter, and carbon dioxide-oxygen is given for 2 minutes at a time. At the same time the patient's position is changed, and this, however severe the operation performed upon him may have been. The more severe and prolonged the operation (particularly if abdominal), the greater is the danger of a postoperative pulmonary complication, this later complication is a far greater danger to the patient than is the change in position. In cases in which consolidation has already developed the use of a tent or chamber with continuous oxygen and intermittent carbon dioxide administration is advisable. Finally in the cases of delayed atelectasis or when the lung appears drowned in its secretions and when cough and expectoration are neither present nor can be induced by rolling the patient from side to side, bronchoscopy should be used. It is a bold measure, at least it is considered such at the present time, but it may be a life saving procedure.

If the theory that postoperative bronchitis, atelectasis, bronchopneumonia and pneumonia are simply different stages or manifestations of the same morbid conditions be correct, then the treatment proposed to overcome bronchial occlusion and insure free drainage of the bronchial tree for 48 hours after operation (when the means of defense of the lung are impaired) will enable us to

avoid postoperative pulmonary complications. In cases in which these are already developed, the treatment described, by aiming at the cause of the complication, the pneumococcal (group 4) bronchitis, will help us avoid their extension and hasten recovery.

## BIBLIOGRAPHY

- ANDRUS W. DE WITT. Observation on the cardio-respiratory physiology following the collapse of one lung by bronchial ligation. *Arch Surg* 1925 x 506
- ARCHIBALD E. and BROWN L. A. Cough. *Arch Surg* 1927 xvi 322
- ARLONC J. de physiologie et de pathologie. 1902 p 291
- ARMSTRONG G. E. Lung complications after operations with anaesthesia. *Brit M J* 1906 i 1141
- BALDWIN H. S. and RHOADES D. R. U. S. P. H. S. Hygienic Laborat. Bull., 1925 cxli 69
- BALL R. P. Bilateral lobar atelectasis. *Arch Surg* 1928 xxvii 82
- BERGAMINI H. and SHEPARD L. A. Bilateral atelectasis (massive collapse of the lung). *Ann Surg* 1927 lxxviii 35
- BINGER C. A. L. and CHRISTIE R. V. Diathermy in pneumonia. *J Am M Ass* 1928 xxi 368
- BINGER M. W. JUDD E. S. MOORE A. L. and WILDER R. M. Oxygen in the treatment of patients with postoperative broncho-pneumonia. *Arch Surg*, 1928 xxvii 1047. *Collect Papers Mayo Clin* 1928 xx 874
- BLAKE F. G. Pneumonia. *Blumer's Bedside Diagnosis* pp 1-26 Philadelphia W. B. Saunders 1928
- BLUMER G. *Bedside Diagnosis* Philadelphia W. B. Saunders 1928
- BOWEN D. R. Acute massive collapse (atelectasis) of the lung. *Am J Roentgenol* 1929 xxi 102
- BRADFORD J. R. Massive collapse of the lungs. *Oxford M J* 1920 ii 127
- Idem. Massive collapse of the lung as result of gun shot wounds etc. *Quart M J* 1918-19 xii 127
- BRISCOE T. G. The mechanism of postoperative massive collapse of the lung. *Quart M J* 1920 xix 203
- BRODIE T. G. and DIXON W. I. Contribution to the physiology of the lungs innervation of the pulmonary vessels etc. *J Physiol* 1904 xxx 476
- Idem. The bronchial muscles and their innervation and the action of drugs upon them. *J Physiol* 1903 p 97
- BOULANT and CHERET. Postoperative massive collapse. *Lancet* III (July) 1928
- CARRIERE. Congestion Idiopathique Pulmonaire (Maladie de Voillez). *Rev de med* 1803 p 675
- CHLUMSKY. Quoted by Mandl. *Deutsche Ztschr f Chr* 1924 lxxvii 165
- CHURCHILL, L. D. Pulmonary atelectasis with especial reference to massive collapse of the lung. *Arch Surg* 1925 xi 480
- CHURCHILL, L. D. and HOLMES G. W. *Arch Surg* 1927 xix 1003
- CLEVELAND N. *Surg Gynec. & Obst* 1919 xxviii 282
- CORYLLOS POL. N. Bronchoscopy in lobar pneumonia. *Am J M Sc.*, 1929 clxxviii 8

Experimental data to appear shortly will show that in experimental atelectasis in dogs, if we extract the obstructing balloon and place the animal in an atmosphere of air containing 5 to 7 per cent of carbon dioxide, the lung will be aerated very rapidly (15 to 60 minutes). Dogs with experimental pneumonia appear to have a far lower mortality rate if left in this atmosphere for a time varying from 6 to 36 hours.

It is not difficult to understand the aeration of the apneumatic lung after the relief of bronchial obstruction. But it is not easy to understand how pneumonic and consolidated lung will be aerated under carbon dioxide hyperventilation. This supposes the elimination of the occluding agent in pneumonia and it is precisely this mechanism which remains obscure. This point is now under investigation. We can state at present that under the influence of carbon dioxide inhalation the bronchial exudate appears to lose its viscosity, is transformed into a thin frothy secretion, which is more easily expectorated or aspirated by the bronchoscope or resorbed, and the lung can therefore drain and become aerated. In dogs which after several hours respiration of carbon dioxide 6 per cent air mixture, survive extremely toxic pneumonias, the change was quite rapid, the animals come so rapidly out of the toxic condition that one cannot help being impressed. This experimental work will be given in detail by Birnbaum and myself in collaboration with Henderson and Haggard in a forthcoming paper. At the present time laboratory and clinical investigations allow us to state that this method constitutes a means of preventing postoperative lung complications far more efficiently than any of the methods thus far employed.

The elimination of other factors favoring development of postoperative lung complications, namely narcotics and posture, should not be neglected. The patient's position in bed should be changed often if there is no other contra indication, a moderate Trendelenburg position is desirable. The use of atropine, which very probably after a suppression of secretion renders it more viscid should be dispensed with.

Once a postoperative lung complication is established, carbon dioxide inhalation is indicated. We should not forget, however, that the liquefied exudate should be expectorated and the method of L. Sante (119), namely turning the patient on the healthy side several times a day in order to induce cough, must be used. We need not be afraid of the convulsive and the occasional asphyxiating cough which may follow the rolling of the patient upon the healthy side. I have never noticed any untoward effect from such cough. If the condition of the patient is such that he cannot expectorate and if after a reasonable time he does not improve, I consider that there should be no delay in aspirating the bronchial secretion by bronchoscope. We need not fear shock from such a procedure. I have already shown that even in toxic medical pneumonias, there is no shock after a skillfully performed bronchoscopy (24). The number of my cases in which carbon dioxide inhalation has been used as a curative procedure is not as yet large enough to allow definite conclusions to be drawn.

In a recent paper, Binger, Judd, Moore, and Wilder have shown that good results were obtained in the treatment of postoperative pneumonia by the use of oxygen inhalations. Judd and Passalacqua used oxygen inhalations, both as a prophylactic and curative measure. In a group of 180 unselected cases, there was no casualty although 43 patients already had a slight degree of pulmonary congestion and 32 patients had obvious signs of pulmonary consolidation.

From my own experience I consider the carbon dioxide and oxygen method superior to simple oxygen inhalation. The latter prevents anoxemia whereas the former by increasing the ventilation of the lungs and very possibly by direct action upon pneumococcus and its liquefying effect upon the exudate strikes at the cause and not only at the symptoms of the disease.

#### TECHNIQUE

The technique I consider quite efficient is as follows. Immediately at the end of an operation (especially abdominal) and independently of the anesthesia used, the patient breathes a mixture containing approximately

8. Idem. Beitr z klin. Chir 1908 lvi 354
- 86 LICHTEIM L. Arch f exper lath u Pharmakol 1879 x 54
- 87 LORD F T J Am M Ass 1916 lxi 559 Pneumonia (Harvard Health Lectures) Harvard University Press 1929
- 88 MANDEL FELIX Zur statistisc der postoperativen lungenkomplkationen und ueber erfolgreiche hestuerungen zu deren prophylaxe Deutsche Ztschr f Chir 1924 clxv, 67, Deutsche Ztschr f Chir, 1921 57, Wien klin Wchnschr 1921 xxvii 214
- 89 MASON R L Massive atelectasis Surg Chin N America 1926 vi 739
- 90 MASTICS F A SPITTIER F A and McNAMEE E P Postoperative pulmonary atelectasis Arch Surg 1927 xv 155
- 91 MELTZER S T Ueber Eine Methode zur experim mentalen Erzeugung Pneumonic etc Beil klin Wchnschr 1914 July p 1351
- 92 MUELLER Verhandl d deutsch Gesellsch f Chir 1901 xxx 560
- 93 MOORE, R. Herrng Breule Refl. J Exper Med 1927 xlii 819
- 94 MORGENROTH and LEVY Beil klin Wchnschr 1911 xliii 1560 1919
- 95 MUELLER F R. Muench med Wchnschr 1897 p 49
- 96 MYERSON M C Pulmonary aspect of tonsillec tomy etc Laryngoscope 1921 xxxii 929
- 97 NEUBER. Arch f klin Chir 1920 p 89
- 98 NOKES G W, and LANDIS H R. M. Diseases of the Chest 3d ed Philadelphia W B Saunders 1924
- 99 PASTEUR W Massive collapse of the lung Brit J Surg 1914 p 587
- 100 Idem Lancet 1908 ii 1351
- 101 Idem Lancet 1910 u 1080
- 102 Idem Am J M Sc 1890 c 242
- 103 PFANNYER. Wien klin Wchnschr 1913 p 34
- 104 PICKHARDT O C Unresolved pneumonia Arch Surg 1928 xvi 192
- 105 POEFFER Deutsche Ztschr f Chir 1902 lxvii 305
- 106 POWERS J H Vital capacity its significance etc Arch Surg 1928 xxvii 304
- 107 PRATT J H. and BUSHNELL G F Physical Diag nosis of Diseases of the Chest Philadelphia W B Saunders 1926
- 108 QUENU and OBERLIN La Pneumonie Postoperative Arch med chir de l'appar respir 1927 u 2
- 109 REINHARD Deutsche Ztschr f Chir p 139
- 110 RIEBERT Zusahe in Berzola Dom Beitrage zur Histologie des Fibrin Pneumonie Arch f path Anat, 1894 cxxxvi 145
- 111 RIGLER L G Massive collapse of the lung Minne nota M J 1926 ix 326
- 112 ROITH Beitr z klin Chir 1920 p 57
- 113 ROLAND C R and CHERET T E Postoperative massive atelectasis Lancet 1928 ccxv 5473
- 114 RUTILLARD T Le Collapsus agu du poumon Presse med 1929 xxxvii 36
- 115 RYFF A Postoperative thrombose und lungenem bolie Arch f klin Chir 1921, cxv 672
- 116 SABIN F R Science 1916 xlv 145
- 117 ST ENGEL Handb d Kinderh 1926, iii 636
- 118 SANTE LEROY Massive atelectasis (collapse) of the lung Ann Surg 1928 lxxxviii 161
- 119 Idem J Am M Ass 1927 lxxxviii 1539
- 120 Santee H E Bilateral massive collapse of the lung Ann Surg 1927 lxxxv 608
- 121 SCAFER Quat J Exper Physiol 1919 xii 231
- 122 SCHLAEPFER, K Ligation of pulmonary artery of the lung Arch Surg 1924 ix 25
- 123 SCOTT W J M Postoperative massive collapse of the lung Arch Surg 1925 x 73
- 124 SCOTT W J M and CUTLER E C Postoperative massive atelectasis (the effect of hyperventilation with carbon dioxide) J Am M Ass 1928 xc 1759
- 125 SCOTT W J M and JOELSON, J J Postoperative massive atelectasis influence of posture Arch Surg 1927 xv 855
- 126 SCRINGER F A C Postoperative massive collapse of the lung Arch Surg, 1925 x 73
- 127 SINGER J J Bronchography Arch Surg 1927 xiv 167
- 128 SENE F R MASON, R. L. and BOGAN I R Pro phylaxis of postoperative pneumonia Annals & Anal 1928 May June
- 129 SOLTAN A B and ALEXANDER Quat J M 1916 xvii 79
- 130 SOLTAN A B Massive pulmonary collapse Brit M J 1925 xv 544
- 131 STARLING H L Human Physiologie 4th ed Philadelphia 1926
- 132 TESCHENDORF W Ueber die Respirationzeit von Cazen in der Brusthehle Arch f Exper Path u Pharmakol 1924 civ 352
- 133 THOENES F Ueber Mediastinalverlagerung bei in filtraten Lungenerkrankungen un baughingsalter Monatschr f Kinderh 1922 xxiii 353
- 134 VAN MECHELEN V Narcose a Lether Arch in temat de pharmacod et Therap 1926 xxxii
- 135 WADSWORTH A Experimental studies on the etiol ogy of acute pneumonitis Am J M Sc, 1904 v 127 831
- 136 WALLGREN A Displacement of the heart in pneu monia Acta paediat 1923 iii 81
- 137 WALTER H Erfahrungen mit optochin by chirurgis an erkrankten Mitt a d grenzgeb d Med u Chir 1928 xxx 18
- 138 WATSON and MEIGHAN Brit M J 1919 p 393
- 139 WHARTON L R and PIERSON T W Minor forms of pulmonary embolism after abdominal opera tions J Am M Ass 1922 lxxix 1904
- 140 WEBER L Ueber active Aenderungen der Arterien len Blutfuhrle der Lungen Arch. f Anat. u Phy siol 1914 suppl p 377
- 141 WESSLER H Suppuration and gangrene of the lung J Am M Ass 1919 lxxii 1918
- 142 WHIFFLE A O A study of postoperative pneu monitis Surg Gynec & Obst 1918 xxvi 29
- 143 WOILLEZ Traité Clinique des Maladies aigues des Organes Respiratoires Paris 1872
- 144 WRIGHT A E Lancet 1912 pp 1633 1701
- 145 YATES J L Vital capacity in intrathoracic therapy Arch Surg 1926 xii 257

- 25 CORVALLON L O L and BIRNBAUM C L The size of the pneumonic lung in lobar pneumonia Am J M Sc 1929 clixvii 15
- 26 Idem The circulation in the compressed atelectatic and pneumonic lung Arch Surg 1929 xix 1346
- 27 Idem Pneumonia considered as pneumococcal massive atelectasis Bull N Y Acad Med 2d series 19 8 p 384
- 28 Idem Pneumonia etc Arch Surg 1929 xvii Part 1 193
- 29 Idem Obstructive massive atelectasis of the lung Arch Surg 1928 xvi 501
- 30 CROSS F B Principles and application of base in the treatment of lobar pneumonia Med J & Rec 1927 iii 21
- 31 CUTLER I C and HUNT A M Postoperative pulmonary complications Arch Surg 1920 i 114
- 32 Idem Postoperative pulmonary complications Arch Lat Med 1922 xxix 449
- 33 CUTLER E C and MORTON J T Postoperative pulmonary complications Surg Gynec & Obst 1917 xvi 621
- 34 CZERNY Verhandl d deutsch Gesellsch f Chir 1905 xxvii 109
- 35 DEMME Wien klin Wchnschr 1913 p 3
- 36 DIXON W E and BRODIE G J Physiol 1903 xxix 97
- 37 DIXON W E and HOYLE T C Studies on the pulmonary circulation I The vasomotor supply J Physiol 1918 lvi 299
- 38 Idem II The action of adrenergic and nicotine J Physiol 1929 lxvii 77
- 39 DIXON W I and LACHLEY O The calanase an instrument for recording the activity of cilia J Physiol 1905 xxvii 395
- 40 DIXON W L and RANSON FRED Broncho-dilator nerves J Physiol 1912-13 xiv 413
- 41 DELOSZYSZAKI A Apparat zur kohlensaure zur kyalation etc Deutsche Ztchr f Chir 1927 cxi 22
- 42 IRRICH CHRISTIE R W and BINGER C A L An experimental study on diathermy J Exper Med 1928 xlvii 741
- 43 FINTHOVEN W Ueber die Wirkung Bronchial muskulatur nach einer neuen methode untersucht Arch f d ges Physiol 1892 li 307
- 44 FISCHERBERG Quoted by Mandl Deutsche Ztschr f Chir 1921 July p 5
- 45 ELLIOTT T R and DINGLEY L A Lancet 1914 i 303
- 46 ELWYN HERMAN Postoperative pneumonia J Am M Ass 1922 lxxix 2154
- 47 Idem Postoperative pneumonia J Am M Ass 1924 lxxvii 384
- 48 FINSTERER I Wien klin Wchnschr 1913 p 39 Wien klin Wchnschr 1918 p 31
- 49 FISCHER F Prevention of postoperative lung complication by inhalation of carbon dioxide Zentralbl f d ges Med 1928 p 2010
- 50 FONTAINE R and HERMANN L G Experimental studies in denervated lungs Arch Surg 1928 xvi 1153
- 51 FONTAINE R Les complications pulmonaires post-operatoires etc Lyon chir 1928 xxv 383
- 52 GOTTSSTEIN G Erfahrungen ueber locale anaesthesia in der Breslauer klinik Arch f klin Chir 1898 lvi 409
- 53 GRIFFITH J P G Am J M Sc 1927 clixv 483
- 54 Idem Massive atelectasis of the lung Med J & Rec, 1926 cxiii 103
- 55 GWYN N B J Ass Am Physicians 1923 xxxvii 411
- 56 HACKENBROECH Deutsche Ztschr f Chir 1910 p 129
- 57 HARRINGTON S W et al Ann Surg 1927 xxix 152
- 58 HEAD J R The effect of operation upon the vital capacity Boston M & S J 1927 cxvii 83
- 59 HEARN W P and CLEGG L H Postoperative massive collapse of the lung Ann Surg 1927 lxxvi 54
- 60 HENDERSON Y and HAGGARD H W Hyper-ventilation of the lungs as a prophylactic measure for pneumonia J Am M Ass 1929 xcii 434
- 61 Idem The treatment of carbon monoxide asphyxias by means of O<sub>2</sub>-CO<sub>2</sub> inhalation J Am M Ass 1922 lxxix 113
- 62 HENDERSON Y HAGGARD N W and CORRY R C Administration of carbon dioxide after anesthesia and operation J Am M Ass 1921 lxxvi 672
- 63 HENDERSON Y Resuscitation from carbon monoxide asphyxia from ether or alcohol intoxication and from respiratory failure due to other causes J Am M Ass 1924 lxxxix 738
- 64 HENIE Arch f klin Chir 1903 lxiv 339
- 65 HIRSCHBERG F J Am J M Sc 1921 clixv 358
- 66 HOELSHER Quoted by Mandl
- 67 HOLMES G W Am J Roentgenol 1924 ii 599
- 68 JAMES E J Am M Ass 1928 xc 612
- 69 JACOBSON C Surg Gynec & Obst 19 4 xxxviii 432
- 70 JACOBSON C and LEE W E Acute massive collapse of the lung Ann Surg 1923 lxxvii 364
- 71 JACOBSON C Bronchoscopy and Esophagoscopy 2ed p 316 Philadelphia W B Saunders 1927
- 72 JUDS L S and PASALACQUA L A The use of oxygen in the postoperative treatment of surgical cases Coll Papers Mayo Clin 1928 ix 818
- 73 KARSNER H T and 4<sup>th</sup> ed J E J Med Res search 1912 xii 205
- 74 KELLING G Verhandl d deutsch Gesellsch f Chir 1905 xxvii 136
- 75 KLINE and WINTERITZ Studies upon experimental work on rabbits intravital staining etc J Exper Med 1915 xxi 311
- 76 KROGH A Anatomy and Physiology of Capillaries New Haven Yale University Press 1921
- 77 KREMER Quoted in Mandl
- 78 LEE W E Postoperative pulmonary complications Ann Surg 1924 lxxix 506 Bull Ayer Clinic Lab 1925 viii 9
- 79 LEE W E CLEGG and TICKER G Postoperative pulmonary atelectasis Ann Surg 1928 lxxviii 6
- 80 LEVORMANT CH and JELLY M F Late atelectatic pulmonary postoperative J de chir 1928 xxxix 527
- 81 LEOPOLD S S Massive collapse and drowned lungs Am J M Sc 19 4 clixv 431
- 82 Idem Massive collapse of the lungs. Rhumers Bedside Diagnosis vol ii p 1,9 Philadelphia W B Saunders 1926
- 83 LETULLI MAURICE Le Poumon Paris Maloine 1924
- 84 LICHTENBERG A Muench med Wchnschr 1906 lvi 2286

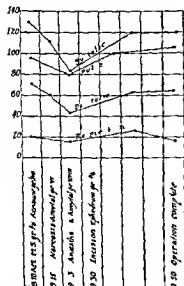


Chart 1. Representative curve of blood pressure, pulse, and respiration. Case 12. Appendectomy. Woman aged 63 years. In this case no supplementary anesthesia was used.

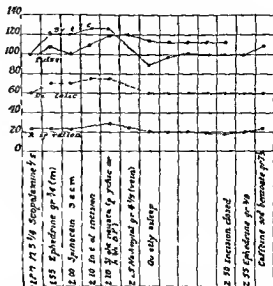


Chart 2. Combined spinal anesthesia and sodium amytal. Case 124. Subtotal hysterectomy. Woman aged 41 years. No inhalation anesthetic necessary. Condition good. Convalescence very pleasant.

spinal anesthesia, smaller amounts must be given, and in these cases it is best to administer the drug by vein because the more rapid action permits more accurate control of the depth of unconsciousness.

Sodium amytal, as described, is soluble and it may be administered orally, intravenously, intramuscularly, or by rectum. In all but two of the surgical cases listed in this report, the administration was by vein. By this route the 10 per cent solution at a hydrogen ion concentration of 9.8 should be injected at a rate not exceeding 1 cubic centimeter per minute; the action is immediate. When given intramuscularly the induction is delayed 10 to 40 minutes, but the effect is more lasting. We have never administered the drug intrapontoonally. In one case of intravenous administration where the solution was spilled into the tissues, a very sore arm resulted, so that we have not given any subcutaneously. By mouth and by rectum larger dosage is required.

#### ACTION

The exact localizing action of the barbiturates is not known. As Isenberger points out they probably act by depressing certain vegetative centers in the hypothalamic portion of

the diencephalon, but this is not established—any more than is the physiology of sleep.

#### INDUCTION

The induction of sleep is rapid and quiet, almost dramatic. During the intravenous administration of the first 3 to 9 grains the patient may remark that he is feeling sleepy, and if engaged in conversation he begins to slur his words, finally he may yawn, and drop off into a quiet sleep in the middle of a sentence, while the drug is still being given. As contrasted with inhalation anesthetics, we have observed an excitement stage in only one case, that of a chronic alcoholic who sang vulgar songs for several minutes before losing consciousness. Several others experienced brief coughing spells during the induction.

While with 3 to 9 grains the patient is asleep, with a few grains more he seems to be reflexively hypersensitive squirming, though asleep, to the slightest needle prick, thereafter, as the dose is increased, more profound anesthesia is produced.

#### REFLEX, BLOOD PRESSURE, AND PULSE CHANGES

The pupils become contracted and in some cases fixed so that they will not react to light.



# EXPERIENCE WITH SODIUM AMYTAL AS AN INTRAVENOUS ANÆSTHETIC<sup>1</sup>

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**A**LTHOUGH for years the barbituric acid derivatives have been used for hypnotic purposes, it has only been since the preparation of the sodium salts of these derivatives that they have been applied in surgical anesthesia. The sodium salts are soluble and are tolerated in doses sufficiently large to be effective.

## HISTORY

In 1924, Fredet in France reported the induction of general anesthesia by the intravenous administration of somnifene, and in 1927 Rumm, in Germany, reported the similar use of pernokton, both barbituric derivatives. In this country in 1916 Page and Coryllos by preparing the soluble sodium salt of iso amyl ethyl barbituric acid were able to inject dogs intravenously and intramuscularly to produce anesthetic relaxation. The dogs went "quietly and rapidly to sleep and awoke after a number of hours active and frisky, without nausea or vomiting." Page and Swanson showed iso amyl ethyl barbituric acid, or amytal to be more effective and less toxic than barbital (Veronal). Subsequently Chambers, Milhorat, Hines and others have studied the effect of sodium iso amyl ethyl barbiturate upon animal metabolism when given in anesthetic doses and their observations are to be found in the literature of the past 4 years.

In February of this year Zerfas and McCallum, of the Medical Research Department of the Indianapolis City Hospital reported the successful induction with sodium iso amyl ethyl barbiturate of general anesthesia in man in about 300 cases and Lundy of the Mayo Foundation, reported in September at the Pan Pacific Surgical Congress 1000 cases surgical and medical, in which this barbituric acid derivative had proved of value. Of these latter cases in the surgical series, however 450 were hemorrhoidectomies in which the acid amytal tablet was given by mouth.

In this paper we wish to report our experience with sodium iso amyl ethyl barbiturate administered to 195 patients.

Amytal is the trade name of iso amyl ethyl barbituric acid. It is marketed in grain and one half tablets for soporific purposes. The sodium salt, on the other hand, i.e. sodium amytal, which is soluble, and with which the following report is concerned, is supplied in pure form, as a crystalline powder with companion ampules of distilled water. When ready for injection the salt is dissolved in the distilled water to give a 10 per cent solution at a hydrogen ion concentration of 9.8. For convenience in this report the sodium iso amyl ethyl barbiturate will be referred to as sodium amytal.

## DOSAGE AND ADMINISTRATION

The dosage is still in the experimental stage. The lethal dose for man is unknown. As with all hypnotics, there is an individual susceptibility factor. This to us, seems of greater importance than the weight of the patient in determining the amount the individual should receive. Susceptibility can best be judged just as in giving inhalation anesthetics, by the color, blood pressure, pulse, and respiration changes as the drug is administered. Age and general strength are important considerations. Very old or debilitated patients may fall fast asleep after 3 to 4 grains have been given while young robust patients may require 7 to 9 grains before they lose consciousness. As a general guide in surgical cases we customarily administer double the amount necessary to put the patient barely to sleep. We no longer give over 22 grains to any patient at one time. This maximum dose may be used for surgery about the face, neck, or breasts, where for convenience or other reasons it is desired not to use supplementary anesthetic agents. Where it is desired to produce only a twilight stupor and retain the cooperation of the patient, as in regional and

<sup>1</sup>Read before the Washington State Medical Association, Yakima, Washington August 29-31 1929 before the King County Medical Society, Seattle, Wash. November 18 1929 and before the Thirty-Ninth Annual Meeting of the Western Surgical Association, Del Monte, Cal. December 12-14 1929.

along with a small amount of ether vapor in order to get sufficient relaxation. In these cases the dosage of sodium amytal has varied from 12 to 22 grains—except in a few very susceptible patients when we first started to use sodium amytal, where the deep cyanosis caused us to cut the dose very low. Since we see but few instances of this initial cyanosis now, we believe it to have been due in these early cases to relaxation and swallowing of the tongue or to an overdose of morphine before hand.

Probably the most satisfactory combination to both surgeon and patient is that of *spinal anesthesia* and sodium amytal. The spinal anesthesia relaxing the muscles ideally for the surgeon, the sodium barbiturate making the patient oblivious of the proceedings in the operating room and adding to his postoperative comfort. Unless thoroughly familiar with both sodium amytal and spinal anesthetics the anesthetist may find it easier first to establish the level of anesthesia with the spinal anesthetic and thereafter administer the sodium amytal, rather than the reverse procedure. For when the sodium amytal is given first the patient often proves hypersensitive and thus makes the lumbar puncture difficult. Further more in using Pitkin's light spinocain the hypersensitiveness necessitates constant guard afterward to prevent the patient from raising his head with consequent danger of respiratory paralysis from ascent of the light spinocain to the medulla. However, with studied judgment, the most satisfactory of all results may be obtained by administering in the room beforehand sufficient sodium amytal to put the patient barely in a twilight stupor such that he is free of anxiety yet can still be aroused to co-operate for the lumbar puncture. Later, after the spinal anesthetic has set, more of the sodium amytal may be given to put the patient entirely to sleep (Table II).

In our endeavor to give the new drug with anesthetic properties a fair experimental trial the surgeon has often had to work at a disadvantage because we have withheld auxiliary agents until they were absolutely necessary. In a number of cases the incision has been made and the peritoneum reached under sodium amytal alone, only to find it necessary to hold

TABLE II.—REGION OR TYPE OF OPERATION

	Cases
Breast	16
Thyroid	23
Nose	4
Face	2
Eye	2
Mastoid	3
Mouth (tongue jaw teeth)	6
Hand (amputation)	1
Clands of neck	1
Gall bladder and bile ducts	15
Kidney	6
Shoulder	3
Laparotomy (inoperable cancer)	3
Appendix	16
Stomach duodenum	3
Small intestine (anastomosis)	5
Cæcum colon rectum	12
Pelvis (uterus tubes ovaries)	27
Pneumum	9
Hernia	3
Varicocele	2
Cystoscopy	1
Spleen	1
Parathyroid	1
Total	165
Medical cases	21
Obs. etical cases	7
Cæsarean sections	2
Total	195

up the operation until sufficient relaxation could be obtained with gas and ether. It is necessary, therefore, to understand the limitations of the drug, and to supplement it at the proper time with the proper anesthetic.

This necessitates that the anesthetist become familiar with the new combination of anesthetics. Otherwise many exasperating and occasionally dangerous conditions may occur. The anesthetist must become accustomed to the changes in the pupillary reactions, in the pulse rate, and in the general muscular tone. New guides to the depth of anesthesia must be established. In several instances the fixation of the pupils, by preventing their dilatation with the dangerous depth of anesthesia, permitted the supplementary anesthetic to be pushed to the point of temporary respiratory cessation before the anesthetist realized that too much ether had been given. In these cases a little oxygen and a few strokes of artificial respiration restored the patient.

#### ADVANTAGES

The chief advantage of sodium amytal in surgical management is the way in which it

TABLE I—SUPPLEMENTARY ANÆSTHESIA USED

	Cases
$N_2O-O_2$ (85% to 50%)	27
$N_2O$ and ether	56
Local procain	10
Local procain and $N_2O$	16
Spinocain—spinal anaesthesia	12
Ether	17
Total	148
Sodium amytal alone	27
Total	165

## PRELIMINARY MEDICATION

In all the surgical cases reported we have given morphine sulphate  $\frac{1}{16}$  to  $\frac{1}{4}$  grain with atropin sulphate  $\frac{1}{150}$  grain one hour prior to the administration of the sodium amytal. In one half of the surgical cases we have followed Lundy's regimen of administering chloretone 10 to 12 grains  $1\frac{1}{2}$  hours before hand. In the cases receiving the preliminary chloretone, sleep was induced with an average of a half grain less of sodium amytal, and the hyperæsthesia seemed to be less marked and of shorter duration. However the reaction time was neither lengthened nor shortened by chloretone and the incidence of restless reactions was not reduced. We are therefore beginning to question the justification of adding chloretone to the already complex combination of hypnotic agents.

## SUPPLEMENTARY ANÆSTHETIC AGENTS

When we first started to use the drug we knew little about it and from the over-enthusiasm of the earlier reports we were led to expect surgical anaesthesia unassisted by other anaesthetics. We soon proved to ourselves that this was inadvisable. As described above the patient becomes hypersensitive after a small dose of the drug then more relaxed as the dosage is increased. But with as large dosage as we feel it wise to use, we have in only 4 cases obtained satisfactory relaxation for abdominal surgery under sodium amytal alone. Two of these were women past 60 years of age and the other two while younger were of asthenic stature and debilitated by chronic illness.

The blood pressure in all but a few of our series fell, the systolic an average of 30 millimeters of mercury, the diastolic an average of 15 millimeters, during the induction of anaesthesia but returned to the normal level early in the operation or else was restored to normal by the administration of ephedrin. In one patient with hypertension and heart block, undergoing an operation for toxic adenoma of the thyroid the systolic pressure fell 100 millimeters of mercury during the administration of the first seven grains of the drug (Charts 1 and 2).

The pulse rate if elevated by emotional excitement was reduced during the induction of anaesthesia. In all other cases however the pulse appreciably quickened after injection of the sodium amytal an average of plus 15 beats per minute. The respirations become shallow and the respiratory rate slightly increased, but in a few cases the respiratory rate fell as low as 12 per minute. The color in all but a few cases has been uniformly good.

The types of supplementary anaesthetics selected are outlined in Table I. In all thyroidectomy cases receiving sodium amytal we have given smaller dosage 8 to 15 grains, in order that the patient might be made to strain and speak at the end of the operation to permit early recognition of hemorrhage or injury to the laryngeal nerves. Hence it had to be supplemented with either local novocain infiltration or light nitrous oxide and oxygen inhalations. For abdominal surgery nitrous oxide and oxygen had to be superimposed in some cases because of the squirming hypersensitiveness of the patient and in other cases

lungs at the end of the operation with the aid of carbon-dioxid-oxygen inhalations is advantageous regardless of the anæsthetic used.

Other complications are listed in Table III. Of the 14 cases in the series with postoperative vomiting, 4 were patients suffering from gall bladder colic, in whom pre operative nausea had been even more marked than was the postoperative nausea. 4 others had had extensive pelvic operations, another was a patient with peritonitis with distention, another had undergone both a cholecystectomy and a Judd operation for peptic ulcer—10 cases in which vomiting was rather to be expected. Of the 4 remaining 2 had had a thyroidectomy, 1 a radical breast amputation, and the last the removal of a stone from the kidney pelvis. All of these except the 2 patients undergoing thyroidectomy and the 1 having the breast amputation received supplementary ether.

The high percentage of catheterizations is deserving of comment. Fifty seven per cent of the females had to be catheterized as against 7 per cent of the males. This may be explained in part by the fact that we have a standing order on the wards for female patients receiving sodium amytal to be catheterized at the end of 12 hours if they have not voided—but for males only if in pain. This is necessary because of restlessness with the relaxed bladder, which cannot empty itself. Three cases of cystitis have resulted with this atonicity of the bladder and catheterization.

In relaxed cases the jaw may droop and the patient be suffocated from swallowing his tongue. So grave a calamity from this source almost befell one of our patients that we now keep a special nurse at the bedside until the patient is fully conscious.

#### LABORATORY FINDINGS

The following laboratory findings are merely a preliminary report and cannot be interpreted as representative of sodium amytal alone, because supplementary anæsthetics were superimposed upon the sodium amytal in the majority of cases, and because we have no control series of similar tests on patients undergoing operations under other anæsthetics. Before they can be so interpreted similar tests must be correlated to rule out the sepa-

rate influence of surgical shock and of the auxiliary agents used.

In 77 patients the average output of urine for the first 12 hours following operation (calculated from the nearest voiding time) was 315 cubic centimeters, for the first 18 hours 430 cubic centimeters, and in 21 recorded cases for the first 24 hours 630 cubic centimeters. In 72 patients the specific gravity of the first urine voided after the sodium amytal averaged 1.011 as against an average of 1.006 for the morning urine voided before sodium amytal. Alkaline urines became acid after the drug, and urines initially acid remained acid. As pointed out by Zerkas, the excretion of urates in the urine is increased. Repeated urinalyses at varying intervals after the drug showed no albumin, casts, or red blood cells.

In 22 patients tested, the average blood urea and creatinin immediately after and 24 hours after the operation under combined sodium amytal and ether anæsthesia showed a slight increase over the fasting level before operation.

In 36 patients the average blood sugar taken immediately after operation under combined sodium amytal and inhalation anæsthesia showed an average increase of 26 milligrams per 100 cubic centimeters over the fasting level before the operation, and an average increase of 27 milligrams per 100 cubic centimeters when taken 24 hours after the sodium amytal. (This series excludes those patients receiving glucose intravenously.) Fifteen of 65 postoperative urines tested gave a positive sugar test. Since we have no blood sugar curves and urine analyses on control cases undergoing operation without sodium amytal and with other anæsthetics used alone, these tests are not conclusive but they do favor support of the findings of Hines, Boyd and Resse. These authors, working with dogs, concluded that sodium amytal interfered somewhat with the glycolytic function of the liver—a point to be remembered in administering the drug.

Red blood counts and hemoglobin readings taken on 65 surgical patients (a) just before, (b) immediately after, (c) 24 hours after, and (d) 30 days after sodium amytal demonstrated no change except a lowering in two cases complicated by secondary hemorrhage. Spectroscopic examination was not performed.

TABLE III — POSTOPERATIVE COMPLICATIONS  
IN ONE HUNDRED FIFTY SURGICAL CASES

	Cases
Nausea	4
Vomiting	14
Headache (all relieved by aspirin)	5
Restless reaction	10
Drunk delirium (13 hours after sodium amytal)	1
Hysterical psychosis 1 to 3 days	3
Deep cyanosis (swallowed tongue)	1
Catheterization necessary only 1 to 5 days after operation	3
Catheterization necessary only 1 to 2 times	4
Involuntary urination	1
Bronchitis	1
Pulmonary oedema	2
Backache	4
Sore arm (from injection)	1
Slut rash	1
Respiratory difficulty on operation table	3

spares the feeling and nerves of the patient. He is put to sleep in his room remembers nothing of the dreaded trip to the operating room reacts partially 2 to 13 hours after the so called "hypodermic," remains in a twilight stupor for 24 to 48 hours longer and in the majority of cases experiences no nausea or vomiting.

Some of the patients who received sodium amytal had had previous operations under inhalation anesthetics and to hear their praise of the 'new anæsthetic' makes one appreciate the real anxiety some patients suffer before going to the operating room. All patients in the series were asked before leaving the hospital for their opinion of the sodium barbiturate, and every one of them even those with restless reactions, was grateful for its administration, and many especially those having been nauseated by ether at former operations were enthusiastic in praise. Several patients requiring a second operation requested the sodium amytal.

Among its other advantages only less important is the fact that the amount of inhalation anæsthetic is reduced by one fourth or more, the depth of ether anaesthesia is more constant, and if nitrous oxide and oxygen are used, the increased proportion of oxygen gives the patient a better color. In waiting for pathological reports on frozen sections the supplementary inhalation anesthetics may be temporarily discontinued without the patient arousing. It has been brought out that the sodium barbiturates successfully control

the convulsions, vasomotor disturbances, and respiratory difficulty of novocain poisoning and this is another advantage in its combination with local anesthesia, where every now and then such a reaction has occurred. In breast amputations the shallow respirations facilitate surgery and may serve to diminish bleeding. In using the live cautery about the tongue and face, we have gotten sufficient relaxation without the use of other anesthetics.

#### DISADVANTAGES AND COMPLICATIONS

Some patients having received the larger dosage become very restless and thrash about the bed and react in a drunken delirium. (This is not true, however, when the drug is given intravenously in small doses.) In the average case of this kind the early administration of morphine and catheterization of the bladder will prove effective. (The bladder loses its tone and cannot empty itself.) Other patients lie motionless so long that there is danger of passive congestion and with the shallow respiration possibility of pulmonary oedema. Pulmonary oedema is the chief complication to be feared. Of two instances in our series one was fatal. This represents the only death in the series in part traceable to sodium amytal. The patient was an old luetic man, very toxic and debilitated undergoing an exploratory operation for obscure abdominal cancer. He received 6½ grams of sodium amytal followed by drop ether. Postoperative pneumonia followed within 12 hours, and the patient died 8 hours after the onset, showing no resistance to the infection. Of course a case of this type is always a bad ether risk and we cannot say that he would not have contracted postoperative pneumonia without the sodium amytal. However sodium amytal does depress the respiratory center and several cases of pulmonary oedema are already on record. It is evident that care should be exercised in the administration of ether to patients who have received sodium amytal and particularly in the case of the aged and debilitated. The other case of congestion cleared rapidly with the use of the oxygen tent and caffeine and promotion of deep breathing on the part of the patient. It should be recalled here that hyperventilation of the

was restless and the weakness and tremors consequent to the reduction of morphine did not seem to be helped by the drug

#### OBSTETRICAL CASES

In conjunction with Doctor Houston Doctor Windom, and others of the hospital's obstetrical staff we are beginning to employ the drug in obstetrical cases, but at present our series is limited to 7 cases, and we can give no opinion of value

#### CONCLUSIONS

Finally, our present impressions concerning sodium iso amyl ethyl barbiturate in surgical cases are as follows. We have come to employ it as a rapidly acting hypnotic rather than as an anæsthetic to take the place of ether nitrous oxide, novocain, etc. In operations about the nose and in using the cautery about the mouth and neck and in the removal of breasts with the cautery, we believe it of singular advantage, and, as mentioned in these cases supplementary anæsthetics have not been necessary, and sodium iso amyl ethyl barbiturate has served as a complete anæsthetic in itself. But to look upon sodium iso amyl ethyl barbiturate primarily as a hypnotic rather than as an anæsthetic is not to underestimate the advantages of the drug or its contribution to the comfort of the surgical patient. In highly strung patients psychic shock can equal surgical shock, and if by putting such a patient knowingly or unsuspectingly to sleep in his room we can reduce this type of shock we have added materially to

surgical management. We believe that by doing away with the anxiety of the trip to the operating room and the psychic suffocation of the ether mask, as much as by adding to the comfort of the patient after operation the sodium barbiturates have won a lasting place in anæsthesia

In the sodium salts of the barbituric acid series the internist has a more dependable hypnotic and a rapidly acting one as well as a control for eclamptic tetanic and strychnine convulsions. These derivative salts will prove a great asset in relieving pain and insomnia not responding to ordinary measures

We feel that there is no contra indication to the use of this drug where surgical interference is necessary except in case of extreme shock uræmic coma diabetes, or respiratory obstruction. It should be given cautiously to the very aged and to those very susceptible to morphine

We wish to thank Drs G M James H R Wesson and A L Carter for their assistance in administering the drug

#### BIBLIOGRAPHY

1. BUNN R. Deutsche med. Wchnschr. 1927 vi 725
2. FREDET P and PERLAIS J. Presse méd. 1924 xxvii 070
3. HINES H M, BOYD J D and LESSEE C E. Am J Physiol. 19 6 LXXVI No 2
4. LINDBY J S. Proc. Staff Meetings of Mayo Clinic 1929 iv No 30
5. PAGE IRVINE H and CORYLLOS IOL. J Pharm & Exp Therap. 19 6 LXXVI 189
6. SWANSON EDWARD E and PAGE IRVINE H. J Pharm & Exp Therap. 1927 xxvii 1
7. ZERFAS L G and McCOLLUM J T C. J Indiana State M Ass. 1929 xxii Feb 15

TABLE IV —MEDICAL CASES

	Cases
Pernicious vomiting of pregnancy	1
Coronary occlusion	2
Renal colic	2
Eclampsia	2
Tetanus	2
Pelvic pain (ca. cervix)	1
Chronic alcoholics	3
Traumatic hysterics	1
Hyperthyroid psychosis	1
Insanity	1
Resistant insomnia	3
Hysterical vomiting	1
Morphine addict	1
Total	21

While these results are not conclusive in a positive way they do tend to support the relative safety of the drug

#### MEDICAL CASES

In application to medical cases, as a pure and rapidly acting hypnotic, we believe the sodium barbiturates will prove of greater advantage than in surgery. With Doctors Palmer and Blackford we have studied the use of sodium amytal in 21 cases as listed in Table IV. Some of these received the drug by vein others by mouth and a few by rectum. In some of the cases we repeated the administration every 24 to 48 hours over several weeks time, with no apparent complications and without the patient acquiring a tolerance for the drug.

The case of pernicious vomiting of pregnancy had not improved with isolation, glucose injections, and sedatives. She was relieved for 2 days by the first sodium amytal injection (5 grains). Recurrences of vomiting necessitated repetition of the drug six times over 18 days before the patient was discharged on a full diet. She was a very grateful patient.

A patient with coronary occlusion who had gotten no relief from 2 grains of morphine, was relieved of the agonizing chest pain by 5 hours' sleep with sodium amytal awaking without any pain. A second case seen, not in the throes of the anginal attack but later with marked orthopnea and insomnia was also grateful to the barbiturate for several nights' sleep.

In the case of a primipara at term with rapidly recurring eclamptic convulsions two doses of sodium amytal (each 4 grains) con-

trolled the convulsions. At the time of the first injection pains were fairly strong and were coming every 5 minutes, the cervix was partially effaced but not dilated, and the fetal heart could not be heard. Four hours later a stillborn babe with rigid extremities, apparently dead some hours, was delivered. One hour after delivery the patient was thrashing about the bed, decidedly on the verge of another convulsion, so that although the pulse was weak and the blood pressure could not be read another dose of sodium amytal was given. The patient was quiet after this, and the blood pressure, pulse, and color improved with rest. However, 18 hours later the pulse became imperceptible and the patient expired.

A second patient experiencing several eclamptic convulsions within 12 hours following delivery of her baby had the convulsions controlled by 10 grains of sodium amytal intravenously. She made a recovery.

We have administered sodium amytal intravenously to 2 patients with tetanus. The first, a man in dire extremity with continuous convulsions, died, although the one injection of the sedative controlled the convulsions. The second a boy 12 years of age, admitted to the hospital in his first tetanic convulsion following 21 days after running a nail in his foot had the convulsions controlled by 5 grains of sodium amytal intravenously. The dosage was repeated in 2 hours and several additional times the next 4 days. Means of large amounts of tetanus antitoxin were administered intravenously and intraspinally while the patient slept. This patient made a recovery and on leaving the hospital remembered nothing of his numerous treatments.

In two of the alcoholics we found large amounts of sodium amytal necessary to control the patient and that even then the sleep was only of 4 to 6 hours duration and the reaction violent. In the third alcoholic it produced a long quiet sleep. As an aid in the Townes Lambert treatment of one morphine addict it proved of no definite advantage. The patient slept 8 hours after 22½ grains of sodium amytal by mouth and 7 hours after repetition of the dose—the morphine having been reduced over a 4 day period before this from 5 grains daily to nil. But the reaction

ceivable that a diverticulum which contains all of the anatomical structures of the intestinal wall may form in youth or adult life and that subsequently, because of some muscular defect or inherent weakness, the mucosa protrudes between the muscle fibers and an acquired diverticulum results. Observers are not in complete agreement as to the exact situation of these diverticula in the circumference of the bowel. A cursory examination of the literature reveals wide divergence of opinion as to whether the diverticula occur more particularly in the weakest spot in the intestinal wall, which is opposite the mesenteric border, or whether they are associated more often with openings between blood vessels which come in from the mesenteric side. In the small intestine, acquired diverticula usually are constant in their relationship to the wall of the bowel, developing at the mesenteric attachment or a little above it. Usually they attain the size of about 1 centimeter in diameter, but occasionally they become many times larger. In the colon, on the other hand, diverticula are not constant in their relation to the mesentery, but may be found at any point along the circumference of the wall of the bowel, a fact which has added to the confusion as to etiology, particularly as it is affected by the relationship of the blood vessels and the longitudinal muscle bands. Keith is the chief advocate of the view that intracolonic pressure as evidenced by contracture of the tamia in the segment of bowel that is host to the diverticula, is the foremost etiological factor. His contention that this results in the formation of circular folds of mucous membrane in the colon, producing obstruction, and resulting in sacculations in the weak spots of the musculature, is not without other advocates, certainly it must be considered among the more satisfactory explanations of the mechanism of production of diverticula. The structural and anatomical influences in the formation of diverticula have received much attention, particularly the relationship of the blood vessels and the longitudinal muscle bands. Drummond called attention to these influences, and his observation that diverticula occur most commonly between the mesentery and longitudinal bands, and that after pene-

trating the muscular coats they follow the shields of the mesentery, has been our clinical experience.

The experimental production of diverticula is extremely difficult because of the conditions under which attempts must be made to reconstruct normal factors as they are in the viable bowel. Chlumsky, Philipowicz, Beer, and others have demonstrated by experiments on intestines of dogs that when injections are made into the small bowel while it still is viable, and before it has been removed from the animal, rupture occurs opposite the mesentery. Just the reverse is true when the bowel has been removed from animals and has been dead for a number of hours, then rupture is into the mesenteric portion. The spaces around the blood vessels, as they enter the mesenteric border of the bowel, are empty and non elastic. Consequently, they do not resist intracolonic pressure in the dead bowel, and their distention by injection of water is not comparable to normal distention, a dead bowel may not be dilated to the size one frequently finds clinically in volvulus. Furthermore, experiments of these same workers have demonstrated that the tear in cases of ileus usually is from the serosal side toward the mucosa. All of this evidence negatives the theory that the weakest portion of the wall of the bowel is in the mesentery and demonstrates conclusively that just the reverse is true, namely that the point of least resistance is opposite the mesenteric border. Beer in his experiments in 1904, refuted many of the hypotheses already advanced as to the production of diverticula and the relationship of constipation, venous stasis, and so forth, to their formation. He emphasized the fact that the supposed weakness at the mesenteric border does not exist and consequently cannot account for the production of all diverticula. He stated that there is some change in the resistant power of the intestinal wall, and that there is consequent muscular deficiency which probably accounts for the formation of false diverticula. Indeed, this hypothesis must be looked on favorably, since it will explain the production of diverticula in both mesenteric and non mesenteric portions of the bowel. According to his hypothesis, diverticula would



DIVERTICULITIS OF THE COLON<sup>1</sup>

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**D**IVERTICULOSIS, or sacculations along the lumen of the large bowel, is a condition uniformly asymptomatic save in a small number of cases in which inflammatory reactions are taking place secondary to the irritating processes. Because of obstruction or for other reasons fecaliths may not be discharged into the colon but may remain imprisoned, to cause a condition no longer recognized as unique, namely diverticulitis.

Anatomically, the acquired diverticulum or diverticula for they are in most instances multiple and may be localized or scattered diffusely throughout the whole length of the large bowel or even throughout the entire gastrointestinal tract represent either a muscular defect or a protrusion of the mucosa through an attenuated spot in the adjacent underlying coats so that there are only two layers in its wall. These two layers are the peritoneum and mucosa, except in the occasional instance in which a true pouch with all the normal intestinal coats develops in adult life and possesses greatly thinned-out coats.

Klebs in 1869 directed attention to the etiological relationship of diverticula to the blood vessels in the intestinal wall. Preceding this contribution, Virchow, in 1853, is credited with having described certain inflammatory areas at the hepatic, splenic and sigmoid flexures of the colon which he termed "isolated circumscribed adhesive peritonitis". His consideration of their sequelae explained the symptoms, although he could not draw a clinical picture of the conditions, he believed that the symptoms usually were interpreted as relating to an inflammation in some other viscus. Graser, in 1898, and Fischer in 1899, again added to the knowledge concerning this condition from material obtained at necropsy. Graser, particularly, emphasized the predominant occurrence of diverticulosis in the pelvic

colon and called attention to the venous congestion without inflammation which occurred in such cases, a view which later experiments apparently has negated.

## ETIOLOGY

The cause and method of production of diverticula continue to be controversial subjects, but the factors involved in the inflammatory processes of diverticulitis are most readily explained by obstruction at the neck of the diverticulum and its concomitant failure to empty. Whether or not the majority of diverticula are of the congenital or of the acquired type is not clear, and it seems that they may be designated as true or false just as accurately from the anatomical standpoint. When the sacculum is composed of all of the structures normally found in the wall of the bowel, arranged in normal sequence, true diverticula are the result, such are typified by Meckel's diverticulum or by the vermiform appendix, which is a normal vestigial pouch. Rarely, a diverticulum similar in structure to the true type may develop during the patient's lifetime, thus precluding its classification as congenital but it is usually the result of traction as reports of cases by Neumann, Nauwerck and Hansemann would indicate. Their rarity makes unnecessary their inclusion in any general classification of diverticula either from the anatomical or the etiological standpoint. Those of the acquired or false type, which occur throughout the gastrointestinal tract may be satisfactorily nominated from the etiological standpoint as either "pull on" or "traction" diverticula. Concerning the traction variety first described by Rokitan sky in 1861 and most commonly associated with the small intestine, Klebs deserves the credit for the suggestion that the pull on the bowel, by the mesentery produces the necessary place of lessened resistance. It is con-

<sup>1</sup>Read before the Interstate Postgraduate Medical Assembly of North America, Detroit, Michigan, October 23 to 25, 1920.

cess formation or fistula, external or internal. It is not uncommon for a vesico intestinal fistula to result from diverticulitis after an abscess has been formed in the pelvis, or after the thickened sigmoid has become attached to the bladder and the process has extended slowly by necrosis. The abscess formation with localized peritonitis which so often gives rise to symptoms which simulate appendicitis save that they are present on the left side, is perhaps the most common complication of this disease. Rarely does a diverticulum perforate through into the abdominal cavity causing generalized contamination. We have seen this occur, but usually the perforation is slow and walled off and results in local, rather than diffuse, peritonitis. The obstruction which results from diverticulitis is peculiar in that it is due to extrinsic inflammatory reaction and contraction of the underlying coats of the bowel, in contradistinction to that produced by ulcerating carcinoma in which the contraction begins from within and progresses outward. The slow inflammatory change that produces stenosis following abscess formation, or occasionally without it, usually results in a fistula, and in our experience these fistulae have been extremely difficult of closure unless we resected the piece of bowel which contained the stricture. Closure with out resection almost invariably fails.

The exact relation of carcinoma to diverticula is questionable. There is no reason why a carcinoma should not develop in the mucous membrane of the diverticulum and this does happen occasionally but there is little evidence to support the view that carcinoma is the result of diverticulitis. Indeed, the association of the two lesions is so uncommon that one may question the diagnosis of carcinoma in association with diverticulitis except under the most extraordinary circumstances. Occasionally carcinoma and diverticulitis are associated and apparently one is able to demonstrate a carcinoma arising from a diverticulum or engrafted on a diverticulum but the percentage of cases occurring thus is almost negligible. We have several times resected the sigmoid for diverticulitis because there has been recent bleeding from the bowel, in the belief that carcinoma was engrafted on

the inflammatory process. With rare exceptions, we have been unable to demonstrate such a change. The so called mimicry of carcinoma, which diverticulitis has been accused of, is infinitely more theoretic than real. This seems the logical conclusion from a study of the 227 cases of diverticulitis in this series which actually required treatment, co existing carcinoma was found in only 4 cases and during the course of operation for carcinoma of the bowel in 679 cases, diverticulosis was present in only 4. If, in such a large group, the conditions are found co existent in only 8 cases, it seems reasonable to believe that the relationship is incidental rather than significant.

#### CLASSIFICATION OF DIVERTICULA

In order to evaluate more carefully the significance and importance of diverticula, we have used the following classification:

- I Diverticulosis including that group of cases in which evidence of diverticula is found by roentgenographic examination or at necropsy and in which, from all available data, the diverticula do not bear any relationship to the patient's complaints
- II Diverticulitis
  - 1 Acute
  - 2 Chronic
  - 3 Complicated
    - a Abscess formation
    - b Fistula
      - External
      - Internal {vesicocolic  
enterocolic
      - Multiple
    - c Associated with malignancy

Ordinarily we consider acute, subacute, and chronic diverticulitis to be fundamentally medical problems and the complications essentially surgical. To serve as a basis for study, we have reviewed the cases of diverticula that occurred over a 5 year period, from 1923 to 1928. The patients in 48 cases of diverticulitis came to operation and 179 were treated by medical measures. After reviewing 234 cases in which diverticula occurred but

develop where the muscular weakness is localized to a small area of muscular tissue, the mucosa would be pushed along the lines of least resistance, the weakened muscle bundles parting, and the direction of the sacculation would be the course of least resistance on the mesenteric sides along the veins. He further stated that larger diverticula, likewise, could be explained in this manner, since larger areas of the musculature could be weakened and could allow the passage of the walls into a sac.

That no one factor produces diverticula seems the most likely conclusion of the study of the experiences of the many observers. It seems reasonable to assume, however, that the outstanding features of their formation have to do with inherent weakness of the wall of the bowel, in addition to increased intracolonic pressure, which results from constitutional or environmental causes. Certainly there must be some congenital predisposition in many cases, and undoubtedly obesity, venous stasis, and constipation, with their vicious cycle of intoxication and lowered resistance, play a part. To this one might add the questionable promoting factor of retrograde peristalsis, but with the mental reservation that there is little conclusive proof as to its actual, positive influence. Once the diverticulum is formed it becomes a bottle shaped process, with a narrow mouth and wide body, into which the fecal current projects itself and from which it is released reluctantly. There is consequent inflammatory change secondary to obstruction and stagnation and the rather constant pathological picture

#### PATHOLOGY

The pathological processes which occur in the diverticula produce inflammatory changes with complications of perforation, stricture, and fistula in some cases. At first these changes are local, and, as they progress they often become extensive and complicated. One should recall, however, that in most instances diverticulitis does not develop on a basis of diverticulosis and that often, when it does develop, it is more likely than not to run a chronic uncomplicated course. Most often the pathological changes which require intervention or treatment occur in the pelvic por-

tion of the colon and in the rectum, probably because of the stasis which normally the fecal current undergoes in this portion of the large bowel. In addition, the character of the intestinal content, which is formed and hard tends to prevent emptying of the diverticulum, once it is packed, the right side of the colon and the small bowel normally housing fluid content, rarely are subject to impaction, obstruction and inflammation. The local inflammatory changes begin, of course, in the mucous membrane of the diverticulum, which undergoes atrophy, with subsequent round cell infiltration of the submucous coats, and lateral ulceration. These changes progress, both in the wall of the bowel and in the mesentery itself, producing symptoms of inflammation or obstruction, according to the amount of encroachment on the lumen from the inflammation, perisigmoiditis, and mesenteritis. The changes in the diverticulum itself are aptly noted by Wilson in a description of a resected specimen, as follows: "The walls of the diverticulum consist of the following coats: (1) mucosa, markedly atrophied around the proximal end of the lumen where pressure has been greatest from the thickened gut walls, and fairly well preserved around the saccular portion, (2) submucosa, a strong fibrous coat, thicker in the proximal than distal portion, (3) muscularis, fibers derived from the circular coat of the sigmoid, and thickened by fibrous infiltration to twice the thickness of the same coat in the normal portion of the sigmoid, the muscularis in the wall, where penetrated by the diverticulum, was much thicker, and (4) a layer of fibrous tissue from the subserosa.

The changes in the coats of the diverticulum vary markedly from attenuation of the musculature to complete absence of musculature in the latter condition. The wall is made up mostly of mucosa and serosa. The chronic thickening of the mesentery, so frequently noted in diverticulitis, is the result of extension of an inflammatory process and at times of perforation into the mesentery. Usually there is marked thickening of the mesenteric attachment as well as contraction and often considerable tumefaction. Perforation of the diverticulum may produce local ab-



FIG. 1 Roentgenogram showing diverticula in the descending colon



FIG. 2 Large diverticula of transverse and descending colon

observed. On the other hand, diarrhea alone was present in 35 cases (11 per cent), and although it was not true diarrhea but usually more of a rectal tenesmus with the passage of a small amount of mucus, pus, and fecal material, it gave sufficient disturbance of the intestinal habit to call the patient's attention to its presence. In 2 cases in this series intestinal passage of apparently pure pus occurred, probably signifying the presence of an abscess which had ruptured into the lumen of the bowel in contradistinction to the usual course of penetrating the peritoneal coat.

Tumefaction was noted in 71 cases (31 per cent), and in a larger number a tender, easily palpable sigmoid was observed. Tumefaction more often than not, represents merely a gross inflammatory reaction around segmental diverticulitis. Its mere presence is not a particularly serious circumstance and is not to be construed as indicating the more serious presence of a malignant condition for in only 4 cases in which tumefaction was present was a malignant condition associated. On the other hand unless the tumefaction is

relieved by regression of the inflammatory process, obstruction, abscess, or a fistula is the result.

The presence of blood in the stool in diverticulitis is probably of small significance from a diagnostic standpoint, and although it was noted in 39 of the cases of this series, usually proctoscopic examination revealed the blood originating in the anal canal. In 20 of the cases bleeding was demonstrated to be around the anal canal by proctoscopic examination, and, consequently, in the presence of tumefaction a malignant condition was suspected, but as has been noted was found in only one of these cases. This is important since previously we have been rather inclined to look on bleeding in the presence of tumefaction and diverticulitis as a rather constant sign of a malignant process and have urged exploration on this account. However, we believe that although one should be on one's guard for carcinoma in the presence of diverticulitis particularly if blood in the stool is observed, although it is not a very reliable or trustworthy symptom.

TABLE I—INCIDENCE OF DIVERTICULUM  
ACCORDING TO AGE

	Cases	Decades						
		20-29	30-39	40-49	50-59	60-69	70-79	80-89
Clinical series	481	1	19	80	94	154	40	4
Necr psy series	111	1		6	30	41	31	3
Total	592	2	19	86	124	195	71	7
Per cent		0.03	3	15	37	33	10	1

seemed unrelated to any of the patient's complaints, we felt that nothing significant was being shown and discontinued further analysis of diverticulosis. Hence this study includes the 481 cases mentioned, to which are appended figures from the necropsy service for this same period. In order to determine, if possible, the occurrence of diverticula, we secured information that there had been 24,620 roentgenograms of the colon, with a diagnosis of diverticula in 1,398 cases. This would suggest an occurrence of 5.67 per cent but this figure is not entirely accurate as it is all but impossible to make deductions for the number of re-examinations that were made. However in a figure this large, the error probably is not great and the figure may be of some significance because at necropsy of 1,925 cases (1924-1928) diverticula were found in 111 (5.2 per cent). It must not be held that 5 per cent represents the occurrence of diverticula for all ages, but refers more to a group of cases in which, for definite or even vague reasons, the colon was examined. The actual occurrence for all ages is probably less than 1 per cent, as estimated from the finding of diverticula in 2,370 cases in the course of 765,793 examinations (1916-1928).

The situation of the diverticula is of interest. They occur most commonly in the sigmoid, but they may be distributed throughout the colon, usually with decreasing frequency from the left to the right side of the bowel. In the series found at necropsy, which is more accurate than clinical observation, diverticula occurred in the sigmoid in only 29 per cent, in the sigmoid and other parts of the colon, in 68 per cent, and in any part but not in the sigmoid, in 3 per cent.

The question of the influence or significance of sex is small. In our series of 481 cases, 60

per cent were males, and in the series of 111 cases in which diverticula were found at necropsy, 70 per cent were males. The relation of age to diverticula is illustrated in Table I.

The fact that in the series of 111 cases in which diverticula were found at necropsy, all cases but one were in patients aged more than 40 years as were 461 in the series of 481 cases emphasizes the assumption that in patients aged more than 40 years the incidence of diverticula is about 5 per cent. It is not possible to estimate accurately the incidence of diverticulitis in relation to diverticulosis but an approximate figure may be obtained from the 1,398 roentgenographic diagnoses in which are included 65 additional examinations of the colon of various patients with diverticula. Hence, in about 1,300 cases of diverticula, 127 are considered to be cases of diverticulitis or approximately 17 per cent of the cases of diverticula seem to be productive of symptoms. This percentage obtained from clinical observations, is somewhat higher than that obtained from necropsy for in the 111 cases there were 16 cases of diverticulitis (14 per cent).

#### SYMPTOMS OF DIVERTICULA

Probably the most common symptom complained of is pain of some kind. Usually it ranges from an intermittent sharp pain probably secondary to formation of gas to a slow boring type of discomfort which is present more or less constantly. There is no typical pain in diverticulitis but the complaint is present in practically every case at some time during the disease. Usually it is situated in the lower left quadrant, or in the lower mid-abdominal section. Its reference depends largely on the accompanying complication which usually is attachment to or perforation of, another viscus. We have seen in the clinic 4 cases in this series in which the pain was referred to the right side but this is extremely unusual. Constipation as one would expect is a rather constant accompaniment of diverticulitis particularly when it has advanced to the complicated stage or when tumefaction with encroachment on the lumen of the bowel is present. In 142 cases (60 per cent of the series), constipation either alone or alternating with diarrhea which was atypical was



Fig 4. In this patient the diverticulosis involved the entire colon



Fig 5 Diverticula in cecum, descending colon and sigmoid

inflammatory tissue on the lumen of the bowel. Antispasmodic drugs, administered until the physiological effect is obtained, will modify the appearance at least of the former but will have little effect on the latter except to relieve concomitant spasm. These filling defects make the roentgenological differential diagnosis of diverticulitis and carcinoma confusing but it can usually be accomplished by careful and painstaking observation. Differential points are the somewhat concentric contours of the segment noted in diverticulitis contrasted with the sharply irregular contours in carcinoma, the maintenance of mobility in the former, compared with the stark immobility of the latter and the relatively long segment of colon involved with diverticulitis whereas carcinoma usually involves a much shorter segment.

Proctoscopic examination is of relatively little value in the diagnosis of diverticulitis save when the lesion is extremely low and the distal portion may be visualized. In the medical group of 179 cases, proctoscopic examination was made in 83. Reports were as

follows: 60, negative for abnormality above the anus, 14, immobile or sacculated sigmoid, 4 pelvic mass, and 5, sufficient visualization to allow of a diagnosis of diverticulitis. Proctoscopic examination was made in 36 of the 48 surgical cases, with negative results in 9, immobile sigmoid was reported in 3, sigmoidal or pelvic mass in 9, and diverticulitis in 10.

The blood picture in diverticulitis is of some diagnostic value but is not of great significance. In 11 of the 48 surgical cases, the haemoglobin was less than 70 per cent, and of these there was carcinoma in 2 cases and an associated bleeding duodenal ulcer in 1 case. Anaemia is an uncommon accompaniment of diverticulitis and when present, indicates usually either a long standing infection or possibly an associated malignant condition.

There is no absolute type of persons more prone to the development of diverticulitis than others but there is a distinct tendency in a certain group of persons who conform to a common anatomical type: a middle aged man preferably a physician inclining toward corpulency and leading a sedentary existence,



Fig 3 Marked spasm proximal to sigmoid with multiple diverticula distributed throughout the sigmoid and descending colon diverticulitis of sigmoid

Symptoms referable to the bladder are common and represent, in most instances, a rather serious complication either attachment to the bladder or attachment to and perforation of the bladder. With a mobile sigmoid, which drops down into the extreme bottom of the pelvis attachment to the bladder is easily accomplished by direct extension of the inflammatory process. Not only is it the most available viscus to become involved but the situation of the involvement, which is usually at the lowest point on the bladder also renders surgical interference which is essential in many of these cases excessively difficult and dangerous. In the surgical group of 48 cases in this series, urinary symptoms were definite in 13 (26 per cent) and in 7 of these there were fistulae into the bladder with the accompanying passage of gas and feces through the urethra. Although this is not always essentially a surgical condition the danger of attending infection from the bladder renders any long standing vesico intestinal fistula a serious condition. The diagnosis of this complication is readily established by

cystoscopic examination, although one should always be able to suspect it from the knowledge of passage of gas or fecal material, or both, through the urethra. In one case of this series there was perforation into the ureter close to its juncture with the bladder and pyuria resulted with a ureterovesico-intestinal fistula.

#### DIAGNOSIS OF DIVERTICULA

Laboratory aid in the diagnosis of diverticulosis consists chiefly in roentgenological examination (Figs 1 to 5). Since the accurate diagnosis is made only by demonstration of the diverticula, and since their involvement in an inflammatory process gives characteristic roentgenological signs, the roentgenological examination holds first place among diagnostic procedures in the establishment of the diagnosis. In The Mayo Clinic the barium enema observed roentgenoscopically, is used exclusively in these cases, the barium meal is eliminated in an effort, of course, to prevent further intestinal stasis by the introduction of a large amount of barium proximal to the suspected lesion. Diverticula manifest themselves roentgenoscopically and roentgenographically as rounded, knob like projections from the lumen of the colon and show considerable variation in size. The sigmoid segment is the favorite site, and the diverticula become less numerous as the examination proceeds more proximally.

Roentgenological evidence of the presence of diverticulitis consists principally of the signs of extreme irritability that always are present with inflammation of a hollow viscus. These signs are spasm and hypermotility and they vary in intensity with the extent severity, and virulence of the process. All degrees of spasm are seen from the mild type manifested by a sharp serrated appearance of the haustra in a somewhat narrowed segment of bowel to almost complete occlusion of the lumen. The filling defect almost universally encountered is either of one type or a combination of two types a false filling defect resulting from spastic narrowing of the affected segment which may be so marked as to produce complete occlusion or a true filling defect resulting from encroachment of pericolic

TABLE II—TYPES OF OPERATION AND CAUSES OF DEATH IN HOSPITAL

Type of operation	Cases	Cause of death	Cases
Mileu's	10	Shock	1
Colestomy	8	Obstruction from diverticulum and acute ulceration of colon	1
Colestomy	1	Pulmonary embolism	1
Colestomy and resection of descending	11	General peritonitis and gangrenous cellulitis of abdominal wall	1
Resection of vesico-intestinal fistula	2		1
Exsufflation	2	Pulmonary suppuration with effusion	1
Exsufflation and separation of abscess and closure of fistula in the small bowel	1	Post-operative hemorrhage	1
Plastic operation and appendectomy	1		
Colestomy	1		

carefully regulated. It is probable that some of the patients in the large remaining group concerning which later data are not available have suffered further trouble or have even suffered from complications. Yet, we believe that most of them will get along satisfactorily if they persist in the care of the bowels and the use of mineral oil.

### SURGICAL TREATMENT

Surgical interference, because of the mere presence of diverticula or even in the early inflammatory stages of the disease, is perhaps not usually indicated and frequently is unwarranted. We believe it more essential to confine surgical operation, in this ailment to chronic complicated cases or to cases of the acute type in which the condition has progressed to perforation. The complications which arise and necessitate surgical intervention are (1) acute perforation, (2) abscess, (3) fistula whether external vesico-intestinal or multiple, (4) inflammatory obstruction and (5) malignancy (Figs. 6 and 7).

Fortunately acute perforation of a mobile segment of the colon where diverticulitis more frequently occurs is unusual. We have seen it in an occasional case in the clinic but it is less common than perforation into the free peritoneal cavity from carcinoma of the colon. Usually perforation from diverticulitis is not into the free peritoneal cavity but

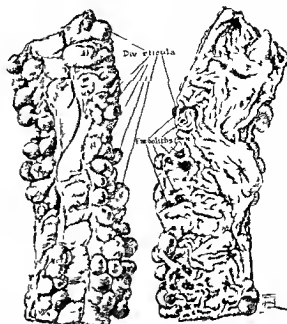


Fig. 7. Multiple diverticula of the descending colon filled with feces.

cause the inflammatory reaction most commonly draws to the sigmoid either loops of the small bowel or fixes the sigmoid to the lateral parietal peritoneum, bladder or anterior abdominal wall. Consequently penetration and abscess more commonly result. In acute perforation, the ideal type of procedure is to remove the offending diverticulum, close the opening and drain the peritoneal cavity. Our experience is small in this type of case and the mortality rate is high. Abscess however is not an infrequent occurrence and demands surgical intervention. Abscess may form against the anterior or lateral parietes and may perforate through the abdominal wall as we have seen it do in one case or it may perforate into a viscus. When it perforates through the abdominal wall a serious condition confronts both patient and surgeon. This usually is the result of long standing inflammation and is accompanied by obstruction from stricture.

We have found in a small proportion of these cases that the most usual operation demanded (Table II) has been removal of the affected sigmoid with end to end anastomosis following drainage by colostomy farther





Fig. 6 Carcinoma of the colon developing in the presence of a diverticulum

in whom with increasing years and a tendency to constipation, a syndrome develops of left sided lower abdominal irritation, possibly pain, and other symptoms associated with advancing inflammatory reaction. This type more often than any other inclines toward diverticulitis.

#### MEDICAL TREATMENT

The treatment of diverticulitis is preferably medical and usually only when complications occur is operation to be undertaken. The presence of a tumor, especially if associated with obstruction, arouses fear that the trouble is malignant and if the other clinical data, particularly the history, do not tend to support the diagnosis of diverticulitis operation must be carefully considered. Medical treat-

ment in acute cases consists essentially of rest in bed, residue free diet at the onset, icebags to the lower part of the abdomen and rectal irrigations with hot physiological solution of sodium chloride. As the condition subsides in the course of a few days a bland anticonstipation diet is instituted and mineral oil is given orally. In the use of the mineral oil we believe it preferable to administer only 4 to 8 cubic centimeters three times daily, rather than 15 to 30 cubic centimeters once or twice daily. Excessive oil merely leaks through the rectum in many instances and gives rise to the desire to discontinue its use. Used in small doses this objection seldom arises and we consider the constant lubrication of the area of the diverticula of such importance as to necessitate continuation of the oil indefinitely. The hot irrigations are discontinued as soon as the inflammatory reaction subsides and the bowel begins to empty naturally. We are not sure of the value of tincture of *bella donna* but since it may help to relax the intestinal spasm it is administered in doses of a 0.33 to 1 cubic centimeter three times daily.

On the patient's dismissal constant diligence in the care of the bowels and daily use of mineral oil must be emphasized. Even in cases of diverticulosis this advice is indicated since it may minimize the potential danger of diverticulitis.

Data on the results of medical treatment are meager, of 37 patients who were treated medically only 2 later came to operation. One had gone along without incident for 6 months, only to suffer a recurrence which rapidly resulted in the establishment of a vesical fistula. The second patient had been under observation for 5 years and had been at the clinic several times for treatment of exacerbation of the diverticulitis. Each time the disease subsided but the patient failed to carry out anticonstipation measures at home. The patient wearying of trying to get along elected operation. Two other patients of the 37 had fairly severe recurrences but they were controlled by medical measures. The remaining 14 have been free or practically free of symptoms for 6 months to 7 years. It was not uncommon to have reference made to some pain and distress, if the bowels were not

10 Tumefaction associated with diverticulitis is common and usually is the result of inflammatory reactions, with or without formation of the abscess. In itself, it does not indicate associated malignancy.

11 The medical treatment of acute diverticulitis consists of watchful waiting while the patient is at rest in bed and is given irrigation of the affected segment of bowel with warm sodium chloride solution and other sedative solutions. As the process subsides anticonstipation diet and the use of small doses of mineral oil orally are given. A dietary regimen is highly essential and probably often prevents complications.

12 In a definite percentage of cases, diverticulitis tends to become complicated. The

most common complications are abscess, fistula, and perforation.

13 The treatment of the complications of diverticulitis is usually surgical, particularly of the internal fistulous formation in which a viscus, such as the bladder, is penetrated by the inflammatory process.

14 Primary resection in the face of complications and diffuse inflammation is accompanied by a relatively high mortality rate. The operation of choice is a graded procedure, consisting of drainage and subsequent resection and anastomosis.

15 Often prolonged drainage by colostomy permits complete recession of tumefactions and disappearance of clinical symptoms rendering unnecessary further intervention.

## MALIGNANT TUMORS OF THE NAIL BED

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**I**n malignant tumors the early stages are often masked by a harmless appearance and insignificant symptoms so that they may be overlooked and the best chances for cure are lost. Those afflicted with benign tumors in the course of years become more less accustomed to them so that the transformation to a malignant stage is often overlooked until the new growth has advanced so far that there is little possibility for a successful removal. Beginning malignant tumors not seldom resemble inflammatory conditions and are mistaken for such especially if they occur in places frequently exposed to slight injuries and, therefore, places in which infections and inflammations are common. This is well illustrated by a pigmented tumor which arises at the border of or beneath the nail. Located between nail and bone with little soft tissue to expand in the tumor destroys the nail and often is still of no considerable size even when the regional lymph glands or distant organs have become invaded by metastases. Since pigmentation may be slight and secondary infections may change the appearance of the exposed surface the easily bleeding granular

mass breaking through the nail suggests an innocent granulation tissue until microscopic examination reveals the true nature of the growth.

From a review of the literature it seems that the melanotic tumors of the nail bed are rare. Since the first description by Boyer in 1854 and Demarguay and Monod in 1855 only about 27 cases have been reported (Womack). Hutchinson has called the condition "melanotic whitlow" which indicates both the resemblance to an inflammatory lesion and the pigmentation. The majority of these tumors were found on the fingers, especially on the thumb (13 cases) while on the toes only 4 have been observed, namely 3 on the great toe (Jones 2 cases, Bonnet) and one on the little toe (Chauvenet and Dubreuilh). These tumors are very malignant and usually come under observation after metastases have developed in the regional lymph glands or in the internal organs.

I recently had the opportunity of examining a characteristic subungual melanoblastoma of the great toe and since so little is known about this tumor and it may so easily

back in the colon, preferably in the transverse colon. Plastic operations usually are of no avail in this complication, and in the presence of acute or subacute inflammation certainly one should not undertake such a formidable procedure as resection. Consequently, it is usually wiser, we believe, to perform a drainage operation and allow the patient to return home for 2 to 4 months applying local treatment to the inflammatory area through the rectum and the colostomy opening. Often the recession is so marked that subsequent removal of the offending segment may be accomplished with little danger. Likewise, in the cases of rather acute diffuse diverticulitis with tumefaction in which one feels that resection should be done because of the extent of the disease and the obstruction present, we have found it most satisfactory to perform a drainage operation and to postpone removal of the lesion for a considerable length of time. In 1 or 2 cases, we have been favorably impressed by the great recession of the growth that has taken place after drainage. In fact we believe that frequently after colostomy has been done in a case of rather diffuse diverticulitis, and after the consequent "side tracking" has been carried on over a sufficiently long period, the recession will be sufficient to allow of omission of subsequent resection. Obviously one must be sure before closing the colostomy opening and abandoning the idea of further operation that there is no obstruction at the primary site of the disease.

Formation of fistula leading into the bowel or the bladder is a serious complication, particularly fistula leading into the bladder. Here the inaccessibility of the two openings makes the surgical procedure extremely difficult. Formerly we were inclined to attempt this type of procedure in one stage, closing the two openings and hoping for primary union. There is always a certain amount of infection around the field and thus a graded operation, namely colostomy first and subsequent attention to the fistula may be done with lower mortality and more satisfactory end results.

When carcinoma is believed to be present even though one may not be absolutely sure of it, resection is indicated. In any case of diverticulitis in which the diverticulum is

suspected of harboring a malignant process the diverticulum should be removed. The type of removal depends on the opinion of the surgeon in many cases, but in our experience a radical operation has been indicated in only a few cases in the presence of inflammation of any extent. The operation of choice is colostomy and subsequent removal of the growth after regression of the inflammatory reaction.

#### SUMMARY AND CONCLUSIONS

1 Diverticulosis is quite prevalent apparently occurring in about 5 per cent of persons who have symptoms referable to the large bowel but probably actually occurring in about 1 per cent of all persons.

2 Diverticulitis probably occurs in about 17 per cent of cases of diverticulosis and in most instances is chronic in its course and subject to exacerbations.

3 The etiology of diverticula is obscure but they are probably the result of several factors among them inherent muscular weakness in the wall of the bowel and environmental conditions obesity and constipation.

4 Diverticulitis probably is the result of improper emptying of the bottle shaped sacculations, with subsequent inflammatory reaction, necrosis and occasional perforation.

5 The relationship of diverticulitis to carcinoma probably is incidental rather than actual.

6 In 227 cases reviewed in this paper, as treated at The Mayo Clinic a malignant condition was found associated in four only.

7 Diverticulitis occurs almost entirely in persons of middle age who are inclined to be corpulent and who lead sedentary lives. Diverticulitis usually runs a chronic course with several exacerbations and yields satisfactorily to dietary and medical treatment.

8 The outstanding symptom of diverticulitis is pain usually situated in the lower left portion of the abdomen and is frequently associated with constipation. Change in bowel habit is a confusing factor.

9 Bleeding is not commonly found among the symptoms of uncomplicated diverticulitis or diverticulosis. When it does occur an associated malignant condition is always suspected but frequently not found.

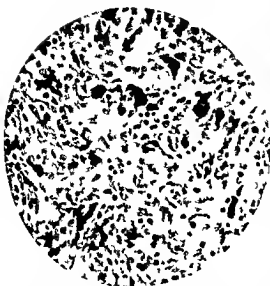


Fig 2. High power magnification of an area near the posterior border. Note the large clear cell free from pigment and the elongated and flattened elements filled with deep brown pigment granules.

tumor. The latter was covered with a layer of fibrin, necrotic cells and degenerated pus cells. In places the tumor tissue bordered directly on stratified epithelium.

The bone was not invaded by the tumor. It appeared rarefied with thin and scanty bony trabeculae and an ample marrow composed of fibrillar connective tissue with perivascular accumulations of plasma cells and lymphocytes (Fig 1).

Histological diagnosis: melanoblastoma of the nail bed. Rarefying osteitis of the terminal phalanx.

The papers dealing with the melanotic tumors of the nail bed say little about the differential diagnosis. There are several benign tumors which occur in this location and which will be discussed later. Occasionally a squamous cell carcinoma may arise in the region of the nail. Its clinical picture resembles that of the melanoblastoma as illustrated by the following case:

#### SQUAMOUS CELL CARCINOMA OF THE NAIL BED OF THE LITTLE TOE

A Russian Jew, 63 years of age, complained of pains in the little toe of the right foot which had been bothering him for several years. These pains had been present all the time but had become more severe during the past few months. The terminal part of this toe was found transformed into a dry, firm mass and the clinical diagnosis of senile gangrene of the little toe was made. Under local anes-



Fig 3. Subungual squamous cell carcinoma of the little toe. Note on the surface the remnant of the nail and the proliferation of the rete malpighi.  $\times 24$ .

thesia, the middle and terminal phalanges were removed. The wound healed *per primam* and the patient left the hospital after 5 days. There were no enlarged glands in the groin or elsewhere.

The specimen consisted of the little toe of the right foot enucleated in the joint between middle and basal phalanx. The nail was replaced by an irregular ulcer which extended over the upper part of the anterior aspect of the toe. The ulcer measured 25 by 12 millimeters in diameter and had slightly raised and scalloped edges. The floor was firm, dry, scaling and of waxy appearance. There were a few pinhead sized depressed areas which were purplish gray in color.

**Microscopic examination.** The dry and waxy tissue on the surface of the ulcer was revealed to be composed of a thick layer of hornified material which was invaded by degenerated pus cells. This material covered irregular branched and budding papillae which extended deep into the cutis and were surrounded by dense accumulations of lymphocytes and plasma cells (Fig 3). The papillae were composed of cells some of which had still retained their prickly shape while others were polyhedral with large and indented nuclei. There were many atypical mitotic figures. In the center of some of the papillae concentric rings of hornified material were present. The bone appeared unchanged.

Histological diagnosis: squamous cell carcinoma of the nail bed.



Fig. 1. Subungual melanoblastoma of the great toe. The nail bed is the site of a cellular tumor the surface of which is ulcerated. The tumor extends close to the bone which shows rarefaction of the trabeculae and fibrosis of the bone marrow.

be overlooked, a description of it seems to be warranted.

#### SUBUNGUAL MELANOBLASTOMA OF THE GREAT TOE

A white German woman aged 69 years complained of pain in the right great toe which had been noticed for 3 years. She attributed the pains first to a poorly fitting shoe. During the last year the toe became swollen and bled on several occasions. A physician who saw her about a year ago diagnosed an inflammation of the nail bed, made an incision and prescribed wet dressings. Since the wound did not heal but grew larger, the patient went to the hospital for further treatment.

The examination revealed a well-nourished woman whose past history is negative except for a rupture of the gall bladder several years ago. According to her knowledge there were no cases of carcinoma in her family. She had 3 children who are living and well. She complained of dyspnoea, shortness of breath, precordial pain and palpitation. The heart was slightly enlarged to the left. Blood pressure was 178/100, pulse rate 92. The urine showed a trace of albumin, a few pus cells and an occasional hyaline cast. Blood count showed red cells 4,800,000, haemoglobin 75 per cent, white cells 7,400, leucocytes 62, lymphocytes 31, monocytes 3, and eosinophiles 2 per cent.

The nail of the right great toe was almost completely replaced by a soft, dark red, and easily bleeding mass. The terminal phalanx was moderately swollen and slightly tender to touch. X-ray examination of the bone was negative. In the right groin there was a mass of enlarged lymph glands, the largest having the size of a hen's egg. Under local anaesthesia the terminal phalanx was removed. The patient had an uneventful recovery and left the hos-

pital after 8 days. The enlarged glands in the groin were treated with deep X-ray therapy and decreased in size. For the last 6 months they have remained stationary.

The specimen consisted of the amputated terminal phalanx of the right great toe. The nail bed was transformed into a roughly oval ulcer 24/27 millimeters in diameter. The edges were sharp, slightly indented, and in places undermined for 1 to 2 millimeters. The floor of the ulcer was firm, finely granular of light purplish gray color and was covered with a thin, adherent, light yellow gray membrane. Near the posterior border there was an irregular deep brown line. Of the nail only a small fragment was left. It occupied the posterior medial part of the nail bed and measured 0.5 millimeters in diameter. A longitudinal section through the middle of the toe showed the purplish gray tissue of the ulcer extending close to the bone and measuring 10 millimeters in vertical diameter. Its posterior part contained several deep brown areas up to 5 millimeters in diameter.

**Microscopic examination.** The nail bed was the site of a very cellular tissue extending close to the terminal phalanx from which it was separated by a thin layer of fibrillar connective tissue. Branched septa of connective tissue divided the tissue into spherical areas from 1 to 2 millimeters in diameter (Fig. 1). From the septa delicate fibers and capillary blood vessels extended into the cellular areas and subdivided them either into small irregular alveoli or narrow cords.

The cells of which the tissue was composed were large and of varying shape. They were round or oval or polygonal and by compression often assumed a spindle shape. These spindle-shaped cells had the tendency to fascicular arrangement.

The cells possessed an ample clear cytoplasm and large round or oval nuclei. The largest of the cells contained two nuclei. The chromatin of the nuclei was finely granular and was evenly distributed. The nuclear membrane was distinct and there was either a small basophilic or a large oxyphilic nucleolus. There were from 3 to 5 mitotic figures to high power field.

The brownish discoloration in the posterior part of the tumor was due to the intracellular accumulation of dark brown pigment granules. The cells filled by the pigment were elongated and branched and the pigment granules which were of even size extended into their branches. In the clear round oval and polyhedral cells no pigment could be demonstrated. Pigmented and non-pigmented cells often mingled with each other (Fig. 2).

The septa contained an occasional accumulation of lymphocytes and single pigmented cells. In these cells the pigment granules were lighter and of irregular size (phagocytized melanin). In none of the locations did the pigment give the iron reaction. It was slowly bleached by hydrogen peroxide.

There were regressive changes in the center of the larger alveoli as well as on the free surface of the

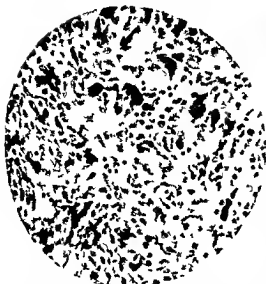


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Histological diagnosis: squamous cell carcinoma of the nail bed.

The malignant tumors of the nail bed can be easily distinguished from the benign tumors because the latter do not break through the nail. These benign tumors are the subungual fibroma (Leduc and Suter), the Dupuytren's subungual exostosis, and a peculiar new growth the origin and nature of which has been much discussed. This tumor has been described under different names such as angiosarcoma, colloid sarcoma and perithelioma, and though its microscopic appearance is somewhat suggestive of a sarcoma the clinical course is benign. According to Masson, the tumor originates in the neuromyoarterial glomus which is arranged about the small arteries of the skin and is composed of smooth muscle fibers and nerve cells. The glomus tumors are non pigmented and consist of blood vessels, muscle fibers, nerve cells and nerve fibers. They are most frequently found beneath the nail (Masson, Martin and Dechaune, and Nicod) but occur also in other places of the extremities (Masson and Gery, Psodanoff). The subungual glomus tumor appears as a blue spot or nodule which is very painful. The pains are excruciating and radiating. The tumor does not destroy the nail, although it may produce a slight depression in the bone. Metastases have never been observed.

In order to distinguish the melanoblastoma from harmless granulomata, the demonstration of pigmented areas or of a pigmented line near the border is of great significance. This pigmentation though often very slight and visible only with the aid of a magnifying glass, secures also the differentiation from a squamous cell carcinoma of the nail the surface of which is dry and waxy.

The malignant tumors of the nail bed occur in higher age. No case of 'melanotic whitlow' has been reported in a patient under 35 years of age and most of the patients are in the sixties or seventies. In about half of the cases of melanoblastoma, a trauma is reported to have preceded the tumor for from 1 $\frac{1}{2}$  to 5 years. In 3 cases the melanoblastoma seems

to have started from a subungual pigmented mole.

Especially as far as the melanoblastoma is concerned, the prognosis is grave. Absence of local metastases does not exclude the involvement of internal organs (Chauvenet and Dubreuilh, Womack, 3 cases). On the other hand patients with enlarged regional lymph glands may survive the amputation of the toe or finger for several years. In the cases in which the lymph glands were not submitted for microscopic examination, it remained doubtful whether the enlargement was due to a metastatic invasion or to a chronic inflammatory irritation.

The treatment of the melanoblastoma of the nail bed is the early radical operation. Most authors agree that X ray or radium are contra indicated. The average length of life after the diagnosis is made is 14 months.

#### CONCLUSIONS

Ulcerative lesions of the nail bed in elderly persons which do not show any tendency to heal should be examined carefully for a possible melanoblastoma or squamous cell carcinoma. In distinguishing the melanoblastoma from benign granulomata and squamous cell carcinoma, the demonstration of pigmented areas which may be very small is of great importance. In this location the carcinoma shows a dry and waxy surface.

#### REFERENCES

- BONNET L. *Lyon méd* 1911 cxvii 366  
 BOYER. *Gaz méd de Par* 1834 p 212  
 CHAUVENET M. A. and DUBREUILH Mlle. *J de méd de Bordeaux* 1927 civ 581  
 DEMARIGNY and MONOD. *Gaz d hôp* 1835 p 415  
 HERTZLER A. E. *Arch Dermat & Syph* 1922 vi 701  
 HUTCHINSON J. *Tr Path Soc Lond* 183, xxxvi 468  
 JONES T. B. *Ann Surg* 1924 lxxx 939  
 MARTIN J. and DECHAUNE J. *Ann d anat path* 1923 ii 3  
 MASSON P. *Lyon chir* 1924 xiv 257  
 MASSON P. and GERY L. *Ann d anat path* 1927 iv 133  
 NICOD J. L. *Schweiz med Wchnsch* 1927 viii 1277  
 PSODANOFF A. *Ann d anat path* 1927 iv 24  
 SPECHT K. *Deutsche Ztschr f Chir* 1927 ccii 390  
 WOMACK N. A. *Arch Surg* 1927 xi 667

THE ABSORPTION AND TRANSIERENCE OF PARTICULATE MATERIAL BY THE GREAT OMENTUM<sup>1</sup>

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**F**UNCTIONS of the omentum such as the elaboration of peritoneal fluid, the absorption of particulate materials or the production of antibodies, have long been known. Ever since Aristotle attributed to the great omentum a function to protect abdominal viscera from the cold, each succeeding scientific generation has contributed its experimental data to our knowledge of the part the organ plays in regulating body economy. Although the literature on the anatomical, physiological, clinical, and surgical significance of the omentum is enormous, complete and exact data concerning it must yet be compiled.

The removal of isotonic solutions and numerous suspensions of particulate material from the peritoneal cavity has been a favorite subject for study since von Recklinghausen described stomata within the mesothelium of the celom through which such particles may be removed. Any study of the method of removing foreign particles from the peritoneum, the type of cellular response to invading organisms, and the routes of drainage from the peritoneum must of necessity include the reaction manifested by the greater omentum.

Whenever foreign particles such as India ink, trypan blue or whole blood, are introduced into the peritoneal cavity, a polymorphonuclear leucocytic reaction follows within the first few hours; mononucleated cells appear in abundance only after 24 to 48 hours. McJunkin (1925) recognized three types of cells determined by the manner in which they take up neutral red in supravital staining. Whether these cells in large part are derived from the omentum has not been determined.

The large number of histocytes which are abundant in the normal omentum leads one to the opinion that this organ may be the source of many of the peritoneal exudate cells and

yet experimental evidence does not thus far warrant such a conclusion.

The literature reporting the cellular response within the peritoneal cavity to any irritation is enormous, and we shall not attempt to review it here. Generally, these exudate cells which arise following peritoneal injection have been attributed to the mesothelium lining the cavity, the reticuloendothelium of the spleen and lymph nodes, the specialized vascular endothelium of the liver, and the greater omentum.

Using a new finely particulate graphite suspension Higgins and Graham (1929) undertook a study of the role of the diaphragm in the removal of foreign particles from the peritoneal cavity in the dog. Special emphasis was placed on the lymphatics of the diaphragm and the routes of absorption through the anterior mediastinum. Higgins, Beaver, and Lemon (1929) continued the study of absorption through the diaphragm of dogs which had been previously subjected either to unilateral or to bilateral phrenic neurectomy. Diaphragmatic paralysis, which follows section of the phrenic nerve, merely retards the rate of absorption but it does not render the diaphragm any the less effective for the removal of injected material from the peritoneum.

During this study of absorption through the diaphragm we were impressed by the speed with which the great omentum in these animals absorbed and fixed the graphite particles. It was apparent at once that the mesothelium covering the omentum reacted far more intensively than the other surfaces of the peritoneum. Poynter (1928) stated that the peritoneum covering the omentum is different from that which covers the visceral and parietal surfaces. Furthermore we have noted, in our study of the relation of the omentum to diaphragmatic absorption, that



animals from which the omentum had been partially resected were not able to withstand the effect of graphite within the peritoneum and usually died within 2 to 3 weeks following an injection. In experiments on dogs that had been subjected to partial resection of the omentum some time before peritoneal injection graphite particles appeared on the pleural surface of the diaphragm following injection as rapidly as in the intact animal. Rubin (1911), however in studying absorption of indigocarmine from the peritoneal cavity of cats from which the omentum had been resected previously noted marked delay in the appearance of the dye in the urine from that which takes place in a normal animal. From our studies it seemed evident that the great omentum was essential to adequate protection but that it did not bear any relation to the absorption of particulate material through the diaphragm.

Restoration of an organ is rather positive evidence that it is essential for the well being of the organism. Its restorative capacity is great and surgeons have noted that at a second laparotomy following earlier partial resection of the omentum it has been restored to its earlier proportions. Arnaud (1928), in the most recent work on the omentum, stated that in both guinea pigs and dogs complete regeneration following resection has taken place in 5 to 6 weeks.

In our study on the absorption of graphite from the intact peritoneum the abundance of black particles within the omentum and the gross appearance suggesting a system of drainage from the organ to the gastric and hepatic regions naturally prompted the inquiry as to whether the omentum could remove absorbed materials and, if so, whether such drainage passes by way of the diaphragm to the thorax. We were interested to know whether material engulfed by the omentum was removed through definite channels carried by way of the blood stream, or perhaps remained as isolated foreign substances within the organ itself.

It is difficult to study the absorptive mechanism of the omentum apart from the other closely related structures of the peritoneal cavity, because the omentum must be

withdrawn from the cavity entirely or be isolated in such a way as to be independent of the adjacent organs. Shipley and Cunningham (1916) were perhaps the first to make a histological approach to the study of omental absorption, and they overcame the spatial difficulty by withdrawing the omentum from the cavity of the body and immersing it in a fluid or suspension, the absorption of which they wished to study. In this way all other drainage routes from the peritoneal cavity were necessarily excluded. In order to maintain anesthesia over periods sufficiently long to permit adequate absorption, decerebrate animals were used so that mechanical difficulties were largely overcome. In this way the omentum could be easily immersed in various solutions and suspensions and studies were made on the rate and the routes of absorption by the omentum in animals so prepared. In certain of the animals, Shipley and Cunningham previously had ligated the thoracic duct in the neck attempting thereby to determine whether or not the lymphatic system was concerned in absorption by the omentum. Their results were unchanged by the ligation of the thoracic duct. In this connection however it must be recalled that should drainage from the omentum pass by way of the diaphragm into the anterior mediastinum a large portion of the lymph will enter the blood stream by way of the right cervical duct so that ligation of the thoracic duct would not be a completely effective control. They concluded that absorption of both solutions and suspensions is by way of the omental veins and that granular material may be recovered from the portal vein and liver within a very short time following immersion in the solution. They stated that lymph vessels if present within the omentum do not play a part in the removal of particulate material. Likewise Poynter (1935) in studying the functions of the great omentum, is convinced that the removal of foreign particles is accomplished by the omental and the portal veins. Poynter did not mention a lymphatic system but he demonstrated crystalloid and various particles and granules in the portal vein within a few minutes following peritoneal injection.

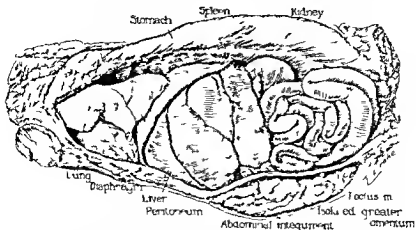


Fig 1. Side view of the body of a cat showing the position of the subcutaneous pouch the isolated portion of the omentum contained therein and the relation of the abdominal viscera to the isolated omentum

In our earlier study on peritoneal absorption, we were unable to recover graphite particles from the liver for a considerable period following peritoneal injection. Furthermore, in sections of the omentum taken at various times following peritoneal injection fixed in Zenker and formol solution and stained with hematoxylin, and with eosin azure we were unable to recognize any graphite particles in any of the omental blood vessels. Numerous particles were adherent to the surface mesothelium and a considerable portion of free graphite was present within the layers, but most striking perhaps was the exceedingly large number of histocytes packed with the phagocytosed particles.

These earlier observations prompted us to try a series of experiments in which we could isolate the omentum from the peritoneal cavity and thus study absorption as carried on by the omentum alone, apart from other adjacent organs and under conditions approaching the physiological. We hoped, too, to determine whether the lymphatics of the diaphragm and the anterior mediastinum had a part in drainage from the omentum as well as in drainage directly from the peritoneal space.

#### EXPERIMENTAL METHOD

Cats were used in this study. In order to avoid the necessity of decerebration and exposure of the omentum to atmospheric condi-

tions we isolated the distal two thirds of the omentum in a pouch formed within the ventral abdominal wall (Fig 1). With the use of Narath's modification of the Talma Morison operation under ether anesthesia and sterile technique an incision about 4 centimeters long was made in the abdominal wall slightly to the right of the median line. By dissecting away the intervening fascia, a pouch of considerable proportions was made between the integument and the layers of muscle. The muscle tissue was incised in the median line, a small incision was made through the peritoneum and the great omentum was carefully withdrawn through this incision and gently placed in the pouch previously prepared between the integument and the abdominal muscles. Caution was observed to avoid any undue manipulation such as tension on the stomach spleen and the transverse colon. In the cat the omentum is extensive and in this way a considerable portion (approximately two thirds) may be withdrawn and thus isolated from the peritoneal cavity. Sutures were inserted around the opening in the peritoneum fixing it firmly to the omentum, so that there might be no spatial continuity between the pouch beneath the integument and the peritoneal space. The skin was then closed. This gave an operative hernia of the omentum. The animals speedily recovered from the operation and in 4 to 5 days ample

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not due to graphite within the blood vessels but to the heavily laden histocytes and free graphite particles which have accumulated around them. Although the graphite is closely packed around the blood vessels, we have never identified a single graphite laden cell or free graphite particle in the blood stream of the omentum in the early periods. Figure 3, the omentum of a dog, represents rather accurately the relations which maintain between the circulation of the blood and the graphite laden histocytes at 3 to 6 hours after peritoneal injection. The peritoneal portion of the omentum in an animal 3 hours after an injection was far less heavily infiltrated than the portion within the pouch and yet an abundance of black material could be detected grossly, up to and including its attachment to the spleen. Sections show that the graphite hitherto at the surface is now within the mesothelial layers and is largely contained within phagocytes, although much free graphite is profusely scattered throughout both the ascending and the descending limbs of the omentum.

The rate of absorption through the isolated omentum is by no means constant for all animals. A cat killed at 6 hours following an injection may not show greater absorption than one killed at 3 or 4 hours so that individual variations may occur. This however, may be due in part also to operative procedures. In general, exploration 3 to 6 hours following a graphite injection into the subcutaneous pouch will show absorption by way of the omentum sufficient to blacken grossly the mesothelial structures related to the spleen and the pancreas inside the abdominal cavity.

Following these early stages the animals were allowed to live for longer periods after the injection had been made into the subcutaneous pouch. Studies were made of the routes of drainage and the site of the absorbed graphite at 12, 20, 24, 36, and 48 hours after injection. Without giving exact details for each animal we wish to report the sequence of absorption and drainage which these experiments have demonstrated.

In each successive experiment all portions of the greater omentum and its normal attachments within the peritoneal cavity were pro-

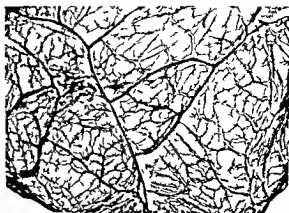


Fig. 3 The omentum of a dog 6 hours after an injection of graphite into the peritoneal cavity

gressively more heavily infiltrated (Fig. 4). In the descending limb of the omentum, the color deposits may be readily traced around the pancreas and thence into the hepatoduodenal ligament. Furthermore, the gastrosplenic ligament becomes progressively more heavily infiltrated and frequently considerable deposits of graphite are observed along the greater curvature of the stomach, especially toward the duodenum. Within the area of the liver, the gastrohepatic ligament (Fig. 5) and the duodenohepatic ligament are heavily infiltrated with black particles. Likewise that portion of the lesser omentum which covers the caudate lobe of the liver is invariably stippled with pigment. The black particles are not on the outside of these ligaments and investing omentum. Sections show that they are definitely beneath the mesothelial layer and occur either as free particles or in wandering histocytes. We have never positively identified any channels of any sort through which the graphite passes in these hepatic ligaments. Microscopically, there seems to be a diffuse distribution of the graphite granules. Forty-eight hours after an injection it is easy to follow the course of the black granules from the hepatic ligaments and the lesser omentum to the coronary ligament of the liver and thence to the central tendon of the diaphragm. We have not studied sections of the coronary ligaments and yet they are invariably speckled black, and, as far as our observations go, represent the only demonstrable course whereby



Fig. 2 Portion of the omentum within the subcutaneous pouch 3 hours after an injection of graphite

time for the wound to heal, 1 to 3 cubic centimeters of the graphite suspension was injected into the pouch containing the isolated portion of the great omentum. Care was exercised in this injection, the needle being introduced through the integument into the posterior region of the pouch to avoid actually injecting the omentum. Following these injections animals were killed at successive intervals: the isolated portion of omentum, the peritoneal portion of omentum, the gastrohepatic omentum, the diaphragm, the anterior mediastinum, and the liver were examined for evidence of absorption of the graphite. Fourteen experiments were considered successful. Careful necropsy was performed at intervals following injection ranging from 30 minutes to 48 hours. These form the basis for the conclusions presented in this report.

#### EXPERIMENTAL OBSERVATIONS

One of the functions of the great omentum is the elaboration of fluid with marked coagulative properties. Arnaud (1928) recently demonstrated the secretory activity of the omentum in guinea pigs by inserting into the abdominal wall a window of transparent cellophane so that he could observe the movements and responses of the omentum. He concluded that the omentum is the source of large quantities of a serous fluid which possesses marked coagulative properties. Our observations bear out these conclusions in that foreign particles in contact with the omentum become at once adherent, held by a coagulum to its

mesothelial surface. Within a few minutes following an injection of graphite into the abdominal pouch the omentum is well speckled with particles which may be washed off only with considerable difficulty. The proximal portion of the omentum within the peritoneal cavity is already faintly gray in places, suggesting graphite, and sections show that the black particles have extended along the mesothelial surface and are still largely adherent. A few very fine granules lie beneath the surface layer. Thus far a phagocytic reaction has not been marked, for only occasionally we encountered phagocytic cells just beneath the mesothelial surface containing only a few black particles.

In a cat killed 3 hours after an injection of 3 cubic centimeters of the graphite suspension into the subcutaneous pouch absorption by the omentum was well advanced (Fig. 2). The fluid then within the pouch contained many polymorphonuclear leucocytes with black granules but whether these arose from the omentum or came from other sources as a result of irritation is as yet unknown. Diapedesis through the mesothelium into the surrounding area was not extensive and we are inclined to believe that more stress is placed on this early activity of the mononuclear phagocyte of the omentum than actual evidence would warrant. Whereas we have noted these phagocytic histocytes within the mesothelium in actual migration we have never seen them so packed with particles in these situations as they are along the blood vessels. It is probable that by far the major phagocytic activity takes place within the tissue of the organ rather than outside the mesothelial layer. At 3 to 4 hours after injection the histocytes along the blood vessels are literally packed with graphite so much so that their nuclear structure is often concealed. In their early phagocytic response these cells may be readily identified by their eccentrically placed nuclei usually of kidney or horse shoe shape. At this period too fibroblasts which are usually non phagocytic or only slightly so have engulfed many graphite particles. Figure 2 shows the extent to which absorption by the portion of the omentum within the pouch has progressed. The major routes of blood vessels appear black.

disprove the existence of a lymph draining system within the great omentum. The demonstration of such a system is exceedingly difficult, since numerous spaces abound in histological sections which make any adequate interpretation impossible. Suzuki (1910) concluded that the omentum regularly possesses a rich supply of lymphatics. Koch (1911), studying both normal and pathological material, supported Suzuki in his contention. Broman (1914) and Crouse (1915) likewise attributed lymphatics to the omentum. Casparis (1918), using the silver nitrate preparation methods, disclosed extensive lymphatics along the larger blood vessels of the omentum in rabbits, cats, dogs, and man. On the other hand, Shupley and Cunningham (1916) and Seifert (1923) were unable to demonstrate lymphatics in the omentum. Marchand (1924) and Poynter (1928) stated that lymphatics are present only in fetal life and for a short time after birth, when they soon disappear. Seifert (1927), however, stated that while he was not able to demonstrate lymphatics in the free portion of the fetal omentum, he could discern them along the attachment to the greater curvature of the stomach.

Our study is not essentially concerned with the presence or absence of lymphatics of the omentum. We were more concerned with the question of fixation of injected foreign particles and especially with their removal to other regions of the body. Although we have made no attempt to disclose lymphatics in the omentum, our observations lead us to conclude that the removal of the absorbed particles is essentially a function of the lymph drainage rather than the blood vascular system. In each animal experiment, we have studied sections of the great omentum which were made from the portion isolated within the subcutaneous pouch and that within the peritoneal cavity but we have never been able to demonstrate any graphite particles in the blood stream. Furthermore we have studied fixed sections of the liver of the cats shortly after injection of graphite and as late as 48 hours after injection and we have failed to identify the black granules within the phagocytic cells. The von Kupffer cells are actively phagocytic and should the graphite have en-

tered the portal vein through the omental circulation, one would expect to identify the particles in these cells lining the sinusoids. We did identify a few mononuclear cells with graphite particles in the sinusoids of the liver of the cat 48 hours after injection, but these were lying free in the blood stream and in our opinion were histocytes that had probably entered the blood stream by way of the anterior mediastinum and the thoracic duct. The fixed or littoral cells were always devoid of the black particles.

Relatively soon following a graphite injection into the pouch, the secretory function of the omentum is early manifested by the abundance of black particles which are firmly adherent to its mesothelium. The extensive vascularity of the organ probably accounts for the large quantities of this serous fluid that is secreted. Within a few minutes these black particles make their way into the omentum where the hitherto inactive histocytes begin their function of phagocytosis. The actual migration of histocytes back and forth through the mesothelium is not frequent and we are inclined to believe that the more extensive phagocytosis occurs within the omentum and not without. The transfer of the free particles into the omentum is very rapid, and one may only conjecture that a return of a certain amount of the fluid into the omentum carries the particles beneath the mesothelium.

After granules have entered the omentum and phagocytosis has occurred, the histocytes accumulate along the larger blood vessels of the organ. Thus these blood vessels appear black in the omentum removed a few hours after an injection. The lumina of these blood vessels are devoid of either the graphite or the graphite laden cells, and the endothelium is likewise clear. The histocytes with graphite granules are closely massed along these vessels and the evidence leads one to conclude that they move along if not in channels, in spaces, surrounding but not connected with the blood vessels (Fig 6). Occasionally, we have noted in our sections an endothelial pattern or space suggesting a lymphatic vessel both with and without graphite and devoid of erythrocytes (Fig 7). These areas have been identified in close proximity to blood vessels and although



Fig 4. The peritoneal portion of the great omentum 48 hours after an injection into the pouch. Large numbers of histocytes may be noted. The blood vessels shown are devoid of free graphite or graphite laden cells ( $\times 400$ )



Fig 5. The gastrosplenic ligament 48 hours after an injection into the subcutaneous pouch. The blood vessels are devoid of graphite ( $\times 500$ )

the graphite may reach the diaphragm. The peritoneal cavity is always clear and we are unable to explain the presence of graphite in these structures on any basis except one involving a direct continuity of drainage from the greater omentum to the diaphragm.

The peritoneal surface of the diaphragm in a cat killed 48 hours after a graphite injection into the subcutaneous pouch presented a picture somewhat similar to that encountered when particles were injected directly into the peritoneal cavity. Strands of black granules accumulated between adjacent bundles of muscle radiated from the central tendon toward the costal margins of the diaphragm. Sections of the diaphragm showed that these particles were beneath the mesothelial surface massed in the intermuscular spaces some within the sub-erosus lymphatic plexus and some without. Free graphite was rarely if ever seen in a serosal cell of the diaphragm. The evidence leads us to conclude that free particles, as well as phagocytic histocytes, work their way assisted by circulating fluids under the mesothelial surface and thence into the extensive lymphatic plexus of the diaphragm.

The passage through the diaphragm is unquestionably by way of the lymphatics and we have demonstrated graphite in the collecting channels on the pleural surface, in the sternal lymph tracts and in the anterior mediastinal lymph nodes. From the central tendon of the diaphragm therefore the

drainage routes toward the anterior mediastinum are identical with those in absorption directly from the intact peritoneal cavity.

#### COMMENT

These studies support very definitely the hitherto recorded observations that the great omentum readily absorbs and removes foreign particulate material. They further show that its secretory activity and its adhesive and absorptive functions are by no means severely impaired when the omentum is withdrawn from the peritoneal space and carefully isolated within a pouch in the ventral abdominal wall.

Our observations are not in accord however with other recorded observations concerning the manner in which these absorbed materials are removed. The lymphatic distribution of vessels within an organ is the system to which the function of absorption and conduction is usually attributed. The existence of a lymphatic vessel system or lymphatic vessels lined by common endothelium within the great omentum of the adult animal continues to be a question of uncertainty. Ranvier (1896) demonstrated lymphatic channels in the great omentum of newborn kittens but he maintained that they disappeared before the animal reached adult age. Lymphatic vessels have been described in the omentum of infants. Subsequently scientific opinion differed and today considerable literature is available which attempts to confirm or

this lobe is the only one covered by the lesser omentum. The distinct infiltration of the ligaments of the liver, all a part of the lesser omentum, rather clearly point to a mesothelial conducting mechanism. The circulation of a fluid containing the free particles and the graphite laden histocytes throughout the extent of the lesser sac are not plausible explanations for the movement of the pigment. The continuity of the lesser sac with the greater peritoneal cavity through the foramen of Winslow would permit a circulation of the granules into the peritoneal space, a phenomenon never encountered.

A further note on the anatomical relations will facilitate an interpretation of the drainage to the central tendon of the diaphragm. If we follow the course of the mesothelium covering the lesser sac, we may observe that it conforms essentially to our pattern of drainage. Starting with the greater curvature this mesothelial layer covers the dorsal surface of the stomach, and extends from the lesser curvature upward to the liver covering the caudate lobe. It is now reflected onto the diaphragm and forms the dorsal layer of the coronary ligament. Thence it passes over the dorsal part of the diaphragm to the vertebral column, descends and covers the ventral border of the pancreas and forms the dorsal wall of the lesser sac and is continued posteriorly to form the inner layer of the great omentum. These anatomical relations rather clearly show how absorption of particulate graphite reaches the diaphragm. As stated the coronary ligament is always heavily infiltrated with graphite in the animals 48 hours after injection. Anatomically the ligament is composed of two layers, a ventral layer composed of peritoneum of the greater sac and a dorsal layer composed of the peritoneum of the lesser sac. The ventral layer of the coronary ligament appears to be less supplied in these drainage experiments than the dorsal layer. This explains we believe the absence of graphite in the serosal surface of the ventral portion of the diaphragm which is anatomically a part of the mesothelium lining the greater peritoneal sac. We believe that most of the graphite enters the diaphragm by way of two closely related routes. One of these is along

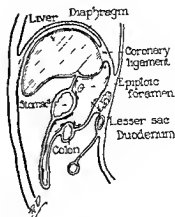


Fig. 8. A diagram of the relations of the fetal omentum to the abdominal cavity.

the posterior wall of the stomach (the anterior wall of the lesser peritoneal sac), thence through the gastrohepatic ligament to the coronary ligament and into the diaphragm. The other route is by way of the pancreas to the crura of the diaphragm along the posterior wall of the lesser sac and then into the diaphragm. The radial distribution of graphite, so frequently seen beneath the peritoneal surface of the diaphragm, occurs by migration along the intermuscular fascia from the site of contact of the diaphragm with the superior recess of the lesser peritoneal sac. Thence, the graphite particles enter the subserous lymphatic plexus of the diaphragm, pass through the partition and enter the collecting channels on the pleural surface. Thus the drainage from the great omentum is by way of those lymphatic channels of the diaphragm and the ventral mediastinum, rather than through the cisterna chyli, and the thoracic duct. There are then, two systems of drainage from the abdomen: one associated with the gastrointestinal tract passing through the mesenteries to the cisterna and the other associated with the omentum and the diaphragm passing through the ventral mediastinum to the cervical lymph ducts.

We do not wish to state that all particles absorbed and fixed by the great omentum are transferred to other parts of the body. We are well aware that the omentum following absorption of particulate graphite from the peritoneal cavity will remain black for many



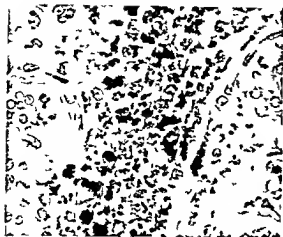


Fig 6 The omentum of a dog 6 hours after pentoneal injection. The accumulation of the histocytes and the free graphite around the blood vessels is shown. The blood stream is devoid of graphite particles ( $\times 1000$ )

they resemble the lymphatic distribution around the portal vein we still hesitate to ascribe to them a lymphatic potentiality.

It may be that the conditions within the omentum are not unlike those within lymph sinuses and myeloid tissue. Maximow stated 'As the lymph sinuses are lined with flattened histocytes so the large venous sinusoids of the myeloid tissue also have a wall consisting not of common endothelium but of flattened histocytes which cannot be separated from the reticular histocytes of the tissue and which show the same functions in an especially high degree: storing of colloidal dyes, phagocytosis of particulate matter, transformation into free macrophages.

Omitting the details of its early development from the dorsal mesentery, the great omentum is formed of four layers of mesothelium two comprising the ascending limb and two the descending limb of the organ. The cavity within this omentum, the lesser sac, largely obliterated in the adult, is continuous with the peritoneal cavity by way of the foramen epiploicum or foramen of Winslow. Thus the peritoneal sac with which we are concerned includes besides the omental bursa or the cavity of the great omentum the cavity of the lesser omentum as well. The lesser omentum is a double layer of peritoneum which extends from the lesser curvature of



Fig 7 The accumulation of graphite-laden histocytes into structures that resemble lymph channels in the omentum. Closely related blood vessels are not shown ( $\times 375$ )

the stomach and the duodenum to the liver, the caudate lobe of which it covers. The duodenohepatic ligament and the gastrohepatic ligament are parts of the lesser omentum. If the two layers comprising the ascending limb of the great omentum are traced forward they enclose the stomach and again unite along the lesser curvature to form the lesser omentum reaching to the liver.

If we are to judge by the distribution of the graphite within the omentum following absorption from the subcutaneous pouch, we must conclude that drainage is to a great extent restricted to the mesothelial layer lining the lesser sac. In tracing the course of drainage around the spleen and to the greater curvature of the stomach by the black deposits in the mesothelium we have noted that the route to the lesser omentum is always over the dorsal surface of the stomach to the gastrohepatic ligament and not over the ventral surface. Furthermore the omental covering of the duodenum and the lobe of the pancreas are always heavily speckled with the black pigment whereas the mesothelial attachment of the colon is less involved. Accordingly we conclude that the mesothelial lining of the lesser peritoneal sac is the layer more largely involved in the drainage of these foreign particles from the great omentum. The fetal relations of these mesenteries shown in Figure 8 will clarify our explanation. The caudate lobe of the liver is the only part of this organ ever speckled with graphite and

# POSTCONCEPTION PELVIC IRRADIATION OF THE ALBINO RAT (MUS NORVEGICUS) ITS EFFECT UPON THE OFFSPRING

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THE findings in two recently completed clinical studies indicate that pelvic irradiation employed during pregnancy is very likely to arrest the development of the fetus. The fact that of 76 full term children irradiated *in utero* 18 were microcephalic—while still other developmental defects were exhibited by some of the remaining ones—definitely points in this direction.

Experiments upon a variety of the lower animals by different observers (1) confirm these clinical findings, although few of these studies were made upon mammals. Irradiation of fertilized animal ova and of immature animal young appeared to be followed in a large proportion of cases by a rather wide variety of physiological and anatomical disturbances e.g., early death, weakness under development, and very high frequency of gross structural deformities. These disturbances seemed to vary with the kind of animal treated, the amount of irradiation employed, and the time of the treatment in relation to the date of fertilization and to other factors.

One of the objects of the present study was to check the results of the other observers in this field. The rat was chosen for our experiments because most of the earlier investigations had been concerned with animals lower in the developmental scale making them less important as a means of evaluating the results of human irradiation.

The desired end of the experiment was to find out whether embryonic irradiation in non-lethal doses would or would not be followed by the birth of young exhibiting gross structural abnormalities.

The irradiation was given with equipment of the mechanically rectifying type, energizing a broad focus Coolidge tube. The roentgen machine was calibrated with a Wulf ionometer; the latter in turn calibrated in Germany with the proposed international 'R' unit. The operating factors were as follows: 127 kilovolts (peak), 5 milliamperes, 30 centi-

meter skin target distance, and 6 millimeters of aluminum. One hundred and eighty milliamperes minutes (m a m.) of exposure gave 800 R units of intensity.

The animals were treated as shown in Figure 1 strapped to the small concentrically arranged tables. The cephalic half of each animal was protected by a lead plate 2 millimeters in thickness. The Coolidge tube target was directed at the central point of the circular base upon which the small tables were fastened with adhesive plaster, the skin target distance (30 centimeters) being measured from the target to the level of the rats' backs.

With this technique, 120 animals were subjected to from 1 to 6 exposures, varying in strength from 45 to 360 milliamperes minutes (200 to 1600 R).

Gestation in the rat consumes from 22 to 23 days. Of the 120 treated animals, 34 cast litters within less than 22 days of their last roentgen exposure, i.e., the embryos in these cases had received at least one roentgen exposure.

The litters of these 34 animals varied in size from 1 to 11, the most common being 2, with an average size of 3.6 young. In 1



Fig. 1. Showing circular base and 4 concentrically arranged tables used for the purpose of holding unetherized adult rats in position for uterine irradiation. Circular bands of zinc oxide adhesive plaster around the upper and lower halves of the body maintain the animal in desired position and check undue movement. Each table is in turn strapped to the circular base. Note the sheet of lead protecting the upper half of the body.

months. We do affirm, however, that a considerable portion of the materials so absorbed, especially the finer particles, may be removed promptly to the diaphragm and thence to other portions of the body, through a mesothelial conducting mechanism operating by way of the omentum.

## SUMMARY

A method is described for the study of absorption by the omentum isolated from all structures within the peritoneum. Studies have been made on the degree of absorption by the isolated omentum from the subcutaneous pouch at frequent intervals, ranging from 30 minutes to 48 hours after an injection. Lymphatic vessels within the omentum have not been demonstrated conclusively and yet absorption from this organ is essentially by way of the lymphatics of the diaphragm and the mediastinum. It was not possible to demonstrate either free particles or graphite-laden histocytes in the omental blood vessels, following an injection into the subcutaneous pouch. Following phagocytosis of the graphite particles by active mobile histocytes these cells accumulate along the blood vessels and pass toward the gastric and splenic attachments of the great omentum. The routes of drainage from the distal part of the omentum follow essentially the mesothelial lining of the lesser peritoneal sac. From the gastrosplenic ligament drainage follows around the dorsal surface of the stomach along the lesser omentum to the caudate lobe of the liver and thence along the coronary ligament of the liver and the central tendon of the diaphragm to the anterior mediastinal lymph nodes.

## BIBLIOGRAPHY

1. ARNALD M. M. A propos de recherches expérimentales sur le rôle physiologique du grand épiploon. *Marseille méd.* 1928 LXX 765-777.
2. BROMAN IVAR. Anatomie des Bauchfellies (Peritoneum). *Handbuch der Anatomie des Menschen* pp 98-102. Jena: Fischer, 1914.
3. CASPARIUS H. R. Lymphatics of the omentum. *Anat. Record* 1918 XI 93-99.
4. CROISE HUGH. The omentum: its embryology and histology: its physiological uses. *Bull. El Paso Co. Med. Soc.* 1915 VII 9-77.
5. HIGGINS G. M., BEAVER M. G. and LEMON W. S. Phrenic neurectomy and peritoneal absorption. *Am. J. Anat.* 1930 LX 137-157.
6. HIGGINS G. M. and GRAHAM A. S. Lymphatic drainage from the peritoneal cavity in the dog. *Arch. Surg.* 1920 XXX 453-469.
7. KOCH JOSEPH. Ueber des Verhalten des grossen Netzes (Omentum majus) bei der peritonealen und intestinalen Infektion. *Med. Klin.* 1911 u. 1952-1954.
8. MCJUNKIN F. A. The origin of the mononuclear phagocytes of peritoneal exudates. *Am. J. Path.* 1925, I 302-324.
9. MARCHAND FELIX. Ueber die Lymphgefässe und die perivascularären Blutbildungszellen des fetalen Netzes. *Arch. f. mikr. Anat.* 1924 LV 311-323.
10. NARATH A. Ueber die subkutane Verlangsamung des Omentum. *Zentralbl. f. Chir.* 1902, XXXI 833-836.
11. POYNTER C. W. M. Concerning the great omentum. *Med. Clin. N. America* 1918 XII 499-503.
12. RANVIER L. Aberration et régression des lymphatiques en voie de développement. *Compt. rend. Acad. d. sc.* 1896 CCXIII 578-580.
13. RECKLINGHAUSEN F. von. Zur Fettresorption. *Arch. f. path. Anat.* 1863 XXVI 172-208.
14. RUBIN I. C. The functions of the great omentum: a pathological and experimental study. *Surg. Gynec. & Obst.* 1911 XII 117-131.
15. SEIFERT E. Studien am Omentum majus des Menschen. *Arch. f. klin. Chir.* 1923 CCXIII 608-633.
16. SEIFERT E. Peritoneum einschliesslich Netz. *Handbuch der mikroskopischen Anatomie des Menschen. Verdauungsapparat I.* 1927 I 337-360.
17. SIMPLEY P. G. and CUNNINGHAM R. S. The omentum as a factor in absorption from the peritoneal cavity. *Am. J. Physiol.* 1916 XL 73-81.
18. SZULAI S. Ueber die Resorption im Omentum majus des Menschen. *Arch. f. path. Anat.* 1910 CCII 238-244.

litter and in more than one litter. Furthermore, no such similar defects were observed in more than 600 control young examined during the previous 2 years. In addition, Dr. Helen Dean King of the Wistar Institute of Anatomy and Biology (from which Institute the mother animals were secured) reports that she has never observed any such defects in the more than 125,000 rats recorded in her laboratory.

#### SUMMARY AND CONCLUSIONS

- 1 The litters of 34 female albino rats, irradiated when pregnant, have been studied.
- 2 In 5 of these 34 litters one or more young exhibited either clubbing of feet or absence of toes.
- 3 The frequency with which defective young were produced appeared to vary directly with the degree of exposure.

4 Though no definite conclusion can be drawn from the observations set down in the present paper, due largely to the scantiness of material available for analysis, it is significant that the deformities observed among the young of animals irradiated when pregnant have not been duplicated in a series of 125,000 non irradiated control animals.

The authors are very greatly indebted to Mr. J. L. Weatherwax, physicist of the Philadelphia General Hospital for his kindness in calibrating the roentgen machine.

#### REFERENCES

- 1 MURPHY, D. P. Ovarian irradiation: its effect on the health of subsequent children: review of literature, experimental and clinical with a report of 320 human pregnancies. *Surg., Gynec. & Obst.*, 1928, xlvii, 201-215.
- 2 *Idem*. Ovarian irradiation and the health of the subsequent child: a review of more than 200 previously unreported pregnancies in women subjected to pelvic irradiation. *Surg., Gynec. & Obst.*, 1929, xlviii, 766-779.



Fig 2 Showing a rat less than one day old which had been irradiated while *in utero*. The centimeter rule indicates the degree of magnification employed in taking the photograph. Note the apparent difference between the degree of development of the hind legs and that of the fore legs in respect to the size and shape of the feet and the depth and length of the digital grooves.

group of 35 control litters the most common size was 7 young.

Grossly defective young were cast by 5 of the 34 irradiated animals. The number of these young appeared to be in direct proportion to the degree of the irradiation. For instance, of the 90 young born of 20 animals which had received only 45 milliamperes minutes (200 R) of exposure, not one was found defective. On the other hand 12 animals exposed to 90 milliamperes minutes (400 R) (twice the above amount) cast 3 litters (one each) containing defective offspring while each of 2 litters exposed to 180 milliamperes minutes (800 R) or 4 times the smallest exposure exhibited one or more defective young. If these 2 latter groups are considered as a single group, it will be observed that of the 14 animals receiving 90 milliamperes (400 R) or more 5 (a percentage of 35.7) gave birth to defective young.

These litters comprised a total of 13 offspring, of which 2 were known to be alive at birth but died within a few hours. The remaining 11 were either stillborn or were killed by their parents or died natural deaths before being observed. Of the whole group of 13 young, 6 exhibited developmental defects of the extremities.

Of the 5 animals casting litters containing defective young 4 gave birth to a total of 10 offspring all of which were at least externally, well formed except for a foot deformity exhibited by 5 of them.

The foot abnormality exhibited by these 5



Fig 3 Showing a rat which had been irradiated while *in utero*. Note the rudimentary development of the second toe on each fore foot. The dark area around the eye is due to a conjunctival discharge.

young (Fig 2) was characterized by lack of the normal depth of the digital grooves. In 4 of the 5 animals only the hind feet were affected while the fifth one exhibited the defect in all 4 feet. In addition, where the digital grooves were absent or distorted the entire foot was deformed so as to appear clubbed. In a number of instances the end of the extremity was perfectly smooth, similar in appearance to an amputation stump of long standing. In those instances in which only the hind feet were affected the fore feet appeared to be perfectly normal in every respect.

The fifth litter consisted of only one young shown in Figure 3. This animal appeared to be perfectly healthy and lived until the end of the experiment. Its fore feet however had only 3 well developed toes each with the normal site of the missing toe marked by a rudimentary bud which suggested an arrest of development.

For a number of reasons it is believed that the abnormalities which have just been described and which are depicted in the two accompanying photographs are the result of the embryonic irradiation. The clinical findings suggest this as does also the earlier experimental evidence advanced by other workers. In the case of the present experiment the defects varied (at least in frequency) with the degree of the embryonic exposure. The same defect was observed several times in the same

anginal pain The physical signs of myocardial insufficiency may be present in varying degrees These include evidence of pulmonary oedema, (rales at the lung bases), hepatic enlargement, and oedema of the extremities

During the past 3 years at the request of Dr Young we have studied the various circulatory problems encountered in patients undergoing prostatectomy in the James Buchanan Brady Urological Institute of the Johns Hopkins Hospital This operation is most often necessary at an age at which the changes described above are well advanced Urinary obstruction, which it is calculated to relieve, carries with it a series of strains upon the circulation, and some of the postoperative complications are prone to bring about myocardial insufficiency Such obstruction, with the resultant impairment of renal function produces a condition which, at the time, may be indistinguishable from chronic nephritis with nitrogen retention and hypertension With the relief of the obstruction these disappear—unless, as in some cases, chronic nephritis and urinary obstruction coexist—but until then the systolic discharge of the heart is opposed by an increased resistance, alone sometimes sufficient to cause symptoms of myocardial failure

A factor of considerable importance in contributing to circulatory failure is the interference with adequate rest Frequency of urination, particularly as it occurs at night may so disturb sleep that the patient becomes well-nigh exhausted Infection, even though localized to the genito-urinary tract, throws an additional burden upon the circulation particularly if it be accompanied by fever

*Pre-operative care* It has become increasingly apparent that the frequency and severity of postoperative cardiac complications may be lessened by adequate pre-operative preparation Rest is a most important pre-operative measure To this end as well as to relieve the frequency of voiding and to restore the renal function catheter drainage should be established Sedatives luminal or even opiates should be employed when necessary In many cases cystoscopy must be delayed until adequate rest has been obtained

*Fluids* Urinary obstruction with its resultant functional renal impairment and

nitrogen retention necessitates the administration of large quantities of fluid And yet any degree of congestive heart failure is to be regarded as an indication for restricting the fluid intake When both conditions are encountered one can steer only a middle course It is impossible to follow the same scheme for every patient The degree of circulatory insufficiency must be determined by careful examination in each case, and the fluid limit established accordingly In our experience it is unwise to force fluids at once in large amounts, following the patient's admission, if signs of myocardial insufficiency be present, but more advisable to increase gradually the fluid intake after 1 or 2 days' rest and digitalization In general, too, in any patient showing signs of myocardial failure, the administration of fluids by the intravenous route is to be undertaken with caution Recently we have adopted the following method<sup>1</sup> A large transfusion needle is inserted into one of the veins in the forearm and strapped in place by adhesive so that it will not slip out The arm is then so fastened to a board that the patient cannot bend the elbow Through the needle normal salt or 5 per cent glucose is injected continuously by a drop method quite similar to the Murphy drip and so regulated that the patient receives not more than 100 to 200 cubic centimeters an hour In this way large amounts of fluid may be given so slowly that the heart is not embarrassed by the increase in volume of the circulation

What are the danger signals? How can one know that the limit of fluid tolerance is being reached? This again must be decided for each case but the most valuable sign is an increase in the number and extent of rales at the lung bases In many such cases moist rales are audible at the lung bases on admission but are usually scattered When large numbers are audible over the lower back on both sides fluid, should be restricted to 2,500 cubic centimeters or less, depending upon the urinary output

*Diet* Patients with oedema should receive a diet poor in salt—10 gram or less daily In cases with impaired renal function the

<sup>1</sup>A similar method was described by Matus Ann Surg 1924  
LXXX 643

## THE CIRCULATORY COMPLICATIONS OF PROSTATECTOMY

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ANY operative procedure upon a patient during the sixth decade of life or thereafter is undertaken in the face of a diminished circulatory reserve. In the younger individual, in the absence of cardiovascular disease, the circulation, with the aid of its compensatory mechanism, is adequate to meet the most varied demands. With advancing age, however, coincident with degenerative changes in the blood vessels and myocardium, its functional reserve gradually decreases. The arteries become more or less sclerosed, irregular plaques are formed in the intima and may involve the medial coat. Diminution in the caliber of the vessels and impairment of the elasticity of their walls result. The changes in the myocardium are somewhat more varied. In the individual fibers histological alterations, pigmentation, occur which make it possible to distinguish an old fiber from a young one. Furthermore, the myocardium may show hypertrophy or fibrosis. The first is the normal response to the increased work required to maintain an adequate blood supply through narrowed inelastic arteries. Unless the valves are damaged or due to emphysema the resistance in the pulmonary circulation is increased this enlargement is confined to the left ventricle. Secondly, the aorta dilates, chiefly in the region of its base and arch. The second change, myofibrosis, is due to one or both of two factors: first, to the normal increase in interstitial connective tissue and wasting of muscle fibers, which occur with age; second, to localized or diffuse muscular degeneration and its replacement by fibrous tissue incident to impairment of the blood supply to the myocardium. The latter is augmented by any sclerotic narrowing of the coronary arteries either at their origin in the aorta or along their course.

Whatever may be the anatomical results of such changes the inevitable physiological effect is an impairment of the capacity of the heart to meet increased demands. The heart's

efficiency depends upon the integrity of its metabolism, this presupposes an adequate blood supply to the myocardium in proportion to the load placed upon it. The circulatory requirements under normal conditions can, in the majority of cases, be supplied but unusual demands (overexertion, fever, hypertension, etc.) cannot be borne without some evidence of circulatory insufficiency.

Physical examination of the senile heart frequently presents the following clinical picture: the impulse is often obscured by overlying emphysematous lung and when visible or palpable it is usually displaced somewhat to the left. The relative cardiac dullness is enlarged particularly to the left and downward and the retrosternal dullness in the first and second interspaces, is widened, corresponding to the dilated aorta. The heart sounds at the apex are distant and feeble, and are often accompanied by a blowing murmur (functional mitral insufficiency). Over the base the aortic second sound may be sharp but in the absence of hypertension, is not greatly accentuated. More characteristic is a systolic murmur in the second right interspace sometimes transmitted upward. This is produced supposedly, either by arterio-sclerotic stiffening of the aortic cusps or by the relative disproportion in the diameter of the normal aortic orifice and the dilated arch. The cardiac rhythm may be normal but is often interrupted by ventricular extrasystoles. Rarely auricular fibrillation may be present.

In the absence of myocardial insufficiency, such patients present few symptoms referable to the heart. They are conscious of limitation of their capacity for physical work and occasionally complain of palpitation; this latter symptom is sometimes lacking even in cases showing numerous extrasystoles. As the circulation becomes overtaxed however more obvious symptoms develop: fatigue, breathlessness while talking, dyspnea on slight exertion, and orthopnea. Finally a small proportion of these patients complain of typical

(or to at most 0.2 gram daily) During the first 2 days after operation this is usually best administered by injection—digitaline 1 to 2 cubic centimeters. Hyperventilation is a most important postoperative measure. The interference with respiration caused by abdominal distention may sometimes contribute to circulatory failure. It should, therefore, be prevented as far as is possible and vigorously combatted as soon as it appears. Certain drugs, and particularly morphine, contribute to distention by relaxing the intestine. Schlesinger's solution and pantopon are less liable to foster distention and at the same time are efficient sedatives. After prostatectomy any treatment per rectum—enema or passage of rectal tube—is to be avoided on account of the danger of embolism. Turpentine stoupees, pituitrin or eserine are usually effective in dispelling distention. To avoid hypostatic pulmonary congestion these patients are turned frequently in bed.

Uncomplicated cases are permitted to sit up in a chair for a half hour on the fourth day after operation. Activity is gradually increased and supplemented by, at first light and then more vigorous massage. When first allowed up many of these patients develop oedema of the feet, ankles, and lower legs. This is particularly true of those who have, for one reason or another, been confined to bed for some time. In the majority of instances this is an evidence of local, rather than general, circulatory insufficiency. The return of venous blood from the lower extremities is, in no small measure, dependent upon the tone of the leg muscles. As this develops, the oedema often disappears. Massage and graduated exercises contribute to this. In an occasional case it is necessary to provide elastic stockings to be worn while walking during the early days of convalescence.

The most alarming postoperative complication is acute cardiac dilatation. In this condition the myocardium becomes suddenly unable to accomplish an adequate systolic discharge. Symptoms and signs of failure rapidly develop, the patient becomes cyanotic, the pulse rapid and thready, the blood pressure falls, the pulse pressure is reduced, pulmonary rales become evident and the liver is engorged.

The heart is often demonstrably enlarged, the sounds feeble, and a gallop rhythm is frequently audible. The cause of dilatation is not always evident immediately. It is theoretically due to increase in the myocardial load beyond the optimum limit in proportion to its blood oxygen supply.

The most common factors causing acute cardiac dilatation are pulmonary embolism and coronary occlusion. The incidence and results of the former have recently been reported by Thomas and Alyea.<sup>1</sup> The abrupt blocking of a greater or lesser portion of the pulmonary circulation suddenly increases the resistance to the output of the right ventricle. The added anoxæmia contributes to the failure of the myocardium by impairing its oxygen supply. Coronary occlusion, by depriving a portion of the myocardium of its arterial supply, may bring about acute and alarming symptoms of dilatation. If the occlusion involves a large vessel, death is the inevitable result. If, however, it occupies one of the terminal branches, compensation may later be restored. Coronary occlusion is attended by symptoms and signs of cardiac dilatation and by moderate fever and leucocytosis.

The patient is often conscious, restless, and extremely apprehensive. A sedative, usually morphia, should therefore, be given at once. If the patient has not been previously digitalized this should be accomplished as rapidly as possible, best of all with strophanthin. The fall in blood pressure is due only in part to peripheral vascular relaxation, it is the result chiefly of the decreased systolic discharge on the part of the heart. For this reason adrenalin should be used cautiously, it may only increase the load upon an already overburdened ventricle. Caffeine is, under these conditions, a far more rational stimulant than adrenalin.

Finally an abnormal rhythm, auricular fibrillation, or, more rarely, flutter, may so interfere with the output of the heart as to cause symptoms of circulatory failure. This may be present upon admission or may develop suddenly following operation. The ventricular rate can be controlled with

<sup>1</sup>Thomas and Alyea, South. M. J. 1929, vol. 23, 1



tention of salt may contribute to the accumulation of *œdema*

**Hyperventilation** With advancing age the thoracic cage becomes more and more rigid as the costal cartilages ossify. At the same time the lungs themselves undergo characteristic changes. The alveolar septa waste and the alveoli coalesce, producing the so called *senile emphysema*. The residual air is increased, the vital capacity is diminished and expansion is limited. Upon auscultation the breath sounds are distant. If the patient has been recumbent prior to examination, dry, crackling rales are audible at the end of inspiration. These are due to the reopening of alveoli compressed in the recumbent position and are to be distinguished from moist rales which are pathognomonic of pulmonary congestion. The circulation in the lung is impeded by any considerable degree of atelectasis and is enhanced by normal pulmonary ventilation. Aside from its effect in reducing the incidence of postoperative pulmonary infection, as reported by Scott<sup>1</sup>, hyperventilation has been found effective in relieving hypostatic congestion both pre-operative and postoperative, in older individuals. This may usually be accomplished voluntarily by the patient, in some cases it must be induced after operation by causing him to inhale a mixture of 5 per cent carbon dioxide in oxygen.

**Digitalis** As has been so often stated the indication for digitalis is myocardial insufficiency, the routine administration of this drug is not only useless but unwise. It should however, be given to any patient showing signs of congestive failure, and in adequate quantity, i.e., 15 grams standard leaves per 100 pounds body weight, or an equivalent amount of some standardized preparation. This is best administered in divided doses over a period of 48 hours or more, except in cases of acute failure, to which it may be given more rapidly. After the maximum therapeutic effect has been obtained, digitalis should be continued at 0.1 to 0.2 gram daily to replace the amount normally excreted. If the patient has received this drug prior to admission digitalis must be administered in smaller doses and a longer period allowed for digitalization

in order to avoid intoxication. The development of acute dilatation calls for an increase in digitalis dosage, or, if the patient has not been fully digitalized previously, for *strophanthin* (0.5 to 1.0 milligram intramuscularly). In cases showing numerous ventricular extrasystoles the combination of digitalis with *dionine* may often restore the normal rhythm more quickly than does digitalis alone. This is given in capsules (*folia digitalis* 0.1 gram, *dionine* 0.006 gram) and continued up to the therapeutic maximum for digitalis.

**Operation** The circulatory strain resulting directly from an operation is due to one or both of two factors. The first is reflected in a reduction of the vital capacity, and is particularly marked in abdominal operations. The normal vital capacity falls steadily during the sixth and seventh decades of life and after until at 80 it is but 45 to 50 per cent that of the normal at 30 years of age. Perineal operations have been shown to be accompanied by little or no reduction in the vital capacity,<sup>2</sup> a fact which we have repeatedly confirmed. As regards the perineal operation, the chief circulatory strain may be due to the second of these factors, i.e., the anæsthetic. Here the choice is often a nice one. Aside from increasing the frequency of postoperative pulmonary complications general anæsthesia, ether or nitrous oxide, is attended by a degree of anoxæmia and secondary circulatory changes which must be regarded as dangerous in elderly patients. Herein lies the advantage of caudal or spinal anæsthesia. Except in occasional, very apprehensive, patients with symptoms of angina pectoris, we have used caudal or epidural anæsthesia, injecting 20 cubic centimeters of a 3 per cent solution of procaine into the sacral hiatus. Morphine (16 milligrams) is given the night before operation to insure rest and again just before operation. Caudal anæsthesia is attended by a fall in blood pressure varying from 20 to 50 millimeters mercury in about 50 per cent of the cases, by a rise of 10 to 30 millimeters in 30 per cent, and by no pressure change in the remainder.

**Postoperative treatment** Digitalis should be continued after operation in doses just sufficient to maintain the therapeutic effect

<sup>1</sup>Scott, W. J. M. J. Am. M. Ass. 1919 vol. 507

<sup>2</sup>Powers, J. H. Arch. Surg. 1918 vol. 304

(or to at most 0.2 gram daily) During the first 2 days after operation this is usually best administered by injection—digitaline 1 to 2 cubic centimeters Hyperventilation is a most important postoperative measure The interference with respiration caused by abdominal distention may sometimes contribute to circulatory failure It should therefore, be prevented as far as is possible and vigorously combated as soon as it appears Certain drugs and particularly morphine, contribute to distention by relaxing the intestine Schlesinger's solution and pantopon are less liable to foster distention and at the same time are efficient sedatives After prostatectomy any treatment per rectum—enema or passage of rectal tube—is to be avoided on account of the danger of embolism Turpentine stoups, pituitrin or eserine are usually effective in dispelling distention To avoid hypostatic pulmonary congestion these patients are turned frequently in bed

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<sup>1</sup>Thomas and Alyea. South M J 1929, xxi, 737

adequate doses of digitalis. In the case of flutter the rhythm may be restored to normal by means of quinidine after digitalization.

### CASE REPORTS

G. P., aged 77 years, admitted to the hospital December 4, 1928, complaining of urinary frequency and urgency which had been present for 4 years. Three years ago he began to have pain over the upper precordium and in the left upper arm following exertion or a heavy meal. Examination in October 1926 revealed benign prostatic hypertrophy with residual urine 400 cubic centimeters. He often felt faint but he never lost consciousness. The diagnosis at this time was arteriosclerosis, cardiac hypertrophy and dilatation and angina pectoris. Blood pressure was 170-90. These symptoms persisted up to time he was last admitted to the hospital.

Physical examination disclosed a large man with arcus senilis, lungs clear throughout. Heart rhythm was regular, rate 80. Impulse was visible in fifth left interspace 11.5 centimeters from midline and was localized and forceful. Relative cardiac dullness measured in first interspace 3.0 centimeters left, and 3.5 centimeters right, in second interspace 3.0 centimeters left and 3.0 centimeters right, in third interspace 6.5 centimeters left and 3.0 centimeters right, in fourth interspace 11.0 centimeters left and 4.0 centimeters right, in fifth interspace 13.0 centimeters left and 4.5 centimeters right. At apex sounds were loud and there was a faint systolic murmur. Over mid and upper portions of the precordium there was another systolic murmur, loudest over the aortic area and transmitted upward into neck vessels. The second aortic sound was loud and ringing. The retinal arteries were narrowed and tortuous. The radials and brachials were palpably thickened. The liver was not enlarged. No edema was present in extremities. Impression: Benign prostatic hypertrophy, arteriosclerosis of peripheral and coronary vessels, dilatation of aorta, cardiac enlargement, angina pectoris.

Patient was prepared for operation over a two week period with rest and digitalis. He got out of bed once and fainted. Blood pressure taken immediately thereafter was 130-80. Perineal prostatectomy was performed December 18, 1928, by Dr. Young. Ether anesthesia was used. Systolic blood pressure during operation varied from 150 to 180. Immediate convalescence was uneventful.

Three weeks after operation patient awakened at night with pain in his left arm. He insisted upon arising next day. That evening he complained of constant dull pain in the upper precordium and left arm, he became apprehensive. Examination showed slight cyanosis and the heart not demonstrably larger than before. Sounds were faint, the apical systolic murmur louder, a presystolic gallop rhythm was audible over the entire precordium. Liver edge 2 centimeters below the costal margin. Patient was confined to bed, sedatives were administered and

digitalis dosage increased for 5 days. Gallop rhythm and pain gradually disappeared. During the week following this attack patient had a fever of 100 to 101 degrees and leucocytosis 10,000. He remained in the hospital 3 weeks after the cardiac attack and then rested at a hotel in the south. Massage and graduated exercise were begun after 2 weeks and were continued after his discharge from the hospital. He returned 4 months later. At this time the physical examination showed the same conditions as were present when he entered the hospital for the first time.

This case illustrates the occurrence of minor coronary occlusion in a patient who had had symptoms of angina pectoris for several years. Operation was undertaken with considerable apprehension and then only after 2 weeks' preoperative treatment and because it seemed absolutely necessary. The choice of ether anesthesia was made for two reasons: (1) The history of syncopal attacks and the observation of one such associated with a fall in blood pressure which made it seem unwise to risk the lowering of pressure frequently associated with caudal or spinal anesthesia, and (2) the excitable temperament of the patient. It was felt that during an operation under local anesthesia, this latter might cause a dangerous rise in pressure.

D. G., aged 76 years, admitted to the hospital in March 1928. His complaint was urinary frequency of 10 years duration. Urinary retention was noticed 6 years prior to admission, during that period the patient catheterized himself. A large vesical calculus was discovered by cystoscopy in January, 1928. Patient was short of breath and had precordial discomfort upon exertion, cramps in the lower legs were brought on by walking. He gave no history of angina pectoris.

Physical examination disclosed a pronounced arcus senilis and clouding of the lens in each eye. Respiratory movements were limited by the rigid thoracic cage, respiratory rate 28 per minute. The percussion note was resonant over both lungs and over the upper portions it was tympanic in quality. Fine moist rales were audible over both bases. Examination of the heart showed impulse visible 9.5 centimeters from the midline in the fifth left interspace. Relative cardiac dullness: first interspace 2.5 centimeters left, 5 centimeters right, second interspace 3.0 centimeters left, 2.5 centimeters right, third interspace 4.5 centimeters left, 3.0 centimeters right, fourth interspace 8.0 centimeters left, 4.0 centimeters right, fifth interspace 11 centimeters left, 4.0 centimeters right. Heart sounds were distant. Systolic murmur at apex was transmitted outward over the aortic area, the systolic murmur was trans-

mitted upward. Ventricular extrasystoles occurred every third cycle. Blood pressure on admission was 100-100. Blood urea 0.64 grams per liter. Vital capacity on admission was 800 cubic centimeters. All superficial arteries were palpably thickened and radial arteries contained calcified plaques in their walls. The retinal arteries were irregularly narrowed. Liver edge palpable 1 centimeter below the costal margin. Slight edema was noticeable over both ankles and tibiae.

The bladder was drained with a retention catheter. 4,000 cubic centimeters of fluid were administered daily. Patient was kept in bed except for 2 hours daily in a chair. He received 12 doses of digitalis leaves 0.1 gram and dionine 0.006 gram within the first 3 days. Digitalis leaves were then continued 0.2 gram daily. Upon the twelfth day after admission the blood pressure had fallen to 160-75 and blood urea to 0.40 gram per liter. Vital capacity at that time was 1,000 cubic centimeters. The liver had decreased in size. Edema of ankles had disappeared. The respiratory rate was 16 per minute. The excretion of phthalein rose from 60 per cent to 80 per cent over a 2 hour period. The ventricular extrasystoles were still present.

Perineal prostatectomy was done by Dr. Young, caudal anesthesia being used. Digitalis was continued at 0.1 gram daily. The patient was confined to bed for 4 days and then allowed to sit up for increasing periods during the subsequent 10 days.

This case presents the problem involved in a patient with advanced arteriosclerosis, moderate hypertension and a low vital capacity who required removal of the prostate for the relief of urinary obstruction. Upon admission there was evidence of myocardial insufficiency. This disappeared as did also the hypertension under preoperative treatment of 12 days' duration. The patient underwent operation without any circulatory complication.

E. S. aged 72 years was admitted to the hospital June 16, 1928. He had suffered from frequency and difficulty of urination for 6 years. He had been frequently catheterized during the last 5 years. Breathlessness was noticed on exertion but there were no symptoms of angina pectoris. The extremities were not edematous. The lungs were clear on percussion and auscultation. The cardiac borders were within normal limits; there was no cardiac enlargement; the sounds were of good quality; no murmurs and rhythm was normal. Blood pressure was 140-90. Urological examination showed a benign prostatic hypertrophy. On June 18, 1928, perineal prostatectomy was done by Dr. Young, caudal anesthesia being used. An attack of acute epigastric discomfort on the fourth day after operation was followed by pain in lower right axilla accentuated by deep

inspiration. Pain was relieved by sedatives and strapping of chest. The next morning movements of right side of the chest were limited on inspiration; there was a small area of dullness in right lower axilla with suppression of breath sounds over this region. No rales and no friction were noticed. Diagnosis: Pulmonary infarction. X-ray examination showed infiltration and pleurisy at the right costophrenic angle. Three days later pain was again noticed in the right chest. Temperature rose to 102.2 degrees and for the next 5 days ranged from 99 to 101 degrees. After the second attack of pain, examination showed a large increase in the area of dullness in the right lower lobe. Patient was disoriented and weak, blood pressure was 100-75 with gallop rhythm at 140 per minute. Three days later bright red blood appeared in the sputum. Cardiac rhythm was now irregular. Patient received 12 grams of powdered digitalis in 2 days and 0.2 gram each day following for 2 weeks. X-ray examination 7 days later showed pneumonia at the right base. Blood streaked sputum persisted for 2 weeks. Temperature gradually fell to 99 degrees. White blood count was 12,400. Signs of thickened pleura at the right base were noticeable for a month. After the patient had sat up in chair his ankles became markedly edematous. Cardiac rhythm continued to be entirely irregular, pulse deficit 50 per cent. There was no edema of the lungs and edema of the extremities disappeared in 1 week. An electrocardiogram showed an auricular flutter. Patient was given 10 gram digitalis in 24 hours, followed by 0.3 gram quinidine. The next day a normal sinus rhythm supervened. A week following this the patient was discharged from the hospital with a normal sinus rhythm, no edema of the extremities or of the lungs.

In this case convalescence was interrupted by pulmonary infarction, acute cardiac dilatation and auricular flutter. With absolute rest, sedatives, and digitalis the patient recovered from the effects of the pulmonary infarction and the signs of circulatory collapse disappeared. The rhythm of the heart reverted to normal under quinidine.

#### SUMMARY

1. Hypertrophy of the prostate, requiring operative removal, usually develops at an age at which the functional circulatory reserve is already diminished.

2. Proper preoperative care, the use of caudal anesthesia, and careful postoperative observation do much toward avoiding circulatory complications of prostatectomy.

The authors are indebted to Dr. Hugh H. Young for permission to study these cases on his service.

## SIMPLE, NON-SPECIFIC ULCER OF THE COLON

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**S**IMPLE, non specific ulcer of the colon is an ulcerating lesion which is not due to the action of any specific organism such as specific ulcer of tuberculosis, syphilis ulcerative colitis, dysentery, typhoid fever, or to the local action of any chemical agent and which is not secondary to or above a malignant tumor causing constriction.

In September, 1928, I published a paper entitled "Simple, Non specific Ulcer of the Colon." The article was a study based on 50 cases collected from the literature and observations on 3 personal cases.

I directed attention to the fact that simple ulcer, analogous to gastric or duodenal ulcer, may occur on any part of the alimentary canal from the oesophagus to the rectum and that the gross and histological characteristics of this lesion are similar in every way to the so called peptic ulcer.

Ulcer of the stomach in association with ulcer of the duodenum or in association with ulcer of the jejunum, ileum, or colon, in the same patient has been observed by some investigators (2, 3, 4). In the series which I studied the combined lesions, ulcer of the stomach and of the colon occurred in 4 cases.

Since the presence of ulcers occurring both in the stomach and duodenum in the same patient is not rare and we are ready to accept the etiology in both ulcers to be the same, it is rational to believe that simple ulcers occurring in the stomach and in other segments of the gastrointestinal tract in the same patient have a common etiology. Because of my findings and the observations of others where the lesions occurred both on the stomach and colon, I am led to believe that there is probably a common etiology. If this is true, it would seem that simple ulcer of the colon must be a manifestation of the same general disease as peptic ulcer, and therefore we must look to causes other than local for the production of these lesions.

Of 53 cases that have been reported in literature since 1837, the pre-operative diag-

nosis of appendicitis was made 11 times, first appearing in literature in 1910. Since 1910 there have been 23 cases reported, of which number the diagnosis of appendicitis was made 11 times—almost 50 per cent. In 10 of the 11 cases, the ulcer occurred either in the cæcum or the ascending colon. The diagnosis of ulcer, when the lesion occurs in the right half of the large bowel is very difficult to differentiate from that of appendicitis. Recently I saw and operated on another patient with a perforating ulcer of the cæcum where a diagnosis of appendicitis was made.

Mrs. C. P., female, age 61 years, white, entered the Surgical Service of the Beth Israel Hospital on April 5, 1929, with a complaint of severe pain in the right lower quadrant. Her family and past history were essentially negative except for mild diabetes mellitus for past 6 months. About 1 week ago she began to have pain in right lower quadrant. Pain gradually became worse and continued for about 1 week being moderately severe until day of admission when suddenly the pain became much more severe. There was no nausea or vomiting. There was no elevation of the temperature or increase of pulse rate until today when there was a slight elevation of temperature. The bowels were regular with catharsis and she had a bowel movement today. She has had a chronic cough for many years but with no expectoration. Menopause occurred 12 years ago—there is no dysuria or hæmaturia. Patient has been on insulin and regulated diet. There never has been any jaundice and there was no history of any previous digestive trouble.

Physical examination disclosed well developed obese woman of 61 years lying in bed complaining of considerable pain in the right lower quadrant. The skin was moist and warm and the face flushed. There was nothing else of note except marked tenderness over the right lower quadrant and some spasm and rigidity of the muscles in this region. The costovertebral angles were not tender—abdomen was tympanitic throughout—no definite mass could be made out over the tender area. A provisional diagnosis of acute appendicitis was made and immediate operation was advised. The results of urine analysis were negative. White blood cells 11,000. Temperature 100 degrees F. pulse rate 100. Respirations 24. Blood pressure systolic 155 diastolic 90.

Operation was done April 5, 1929. Under local anesthesia a McBurney incision was made. There escaped a slight amount of a seropurulent exudate.

The cæcum was found indurated and adherent to the parietal peritoneum. The vermiform appendix was found to be much smaller than normal almost obliterated and could not possibly have accounted for the inflammatory reaction within the peritoneal cavity and the patient's clinical condition. It was removed however in the usual manner. Since the cæcum was found to be indurated and adherent it was impossible to continue the operation without the aid of a general anæsthetic. On account of the patient's condition nitrous oxide and oxygen was used. The cæcum was then freed and an indurated mass about the size of a silver half dollar found in the posterior lateral aspect. The induration corresponded to an isolated ulcer, the center of which revealed a perforation about the size of a lead pencil in diameter from which was escaping intestinal contents. There was no evidence of any other ulcer or enlarged glands and it was felt that this was a non-malignant ulcer and there was nothing to suggest this being a tuberculous ulcer. A small piece was taken from the edge of the perforation for histological examination. The perforation was sewed with fine chromic catgut. The serosa of the cæcum was sutured over the closure with linen. The abdomen was then closed in the usual manner and two cigarette wicks were placed to the right iliac fossa.

Patient made an uneventful convalescence and she was discharged well on April 22, 1929. The operative wound was well healed throughout.

**Pathological report.** Source of specimen appendix biopsy of inflammatory mass in cæcum. Specimen consists of a roughly pyramidal piece of tissue 1.2 centimeters in height and 5 millimeters broad at the base. The lower 4 millimeters is yellowish white and moderately firm and seems to be fat. The remainder is uniformly softer and pink. Two sides of the pyramid are smooth and appear as if cut with a knife. The other two sides are granular and the angle between them is blunt. At the apex of the pyramid is a tiny notch. Accompanying the specimen is an appendix which measures 7 centimeters in length. The proximal 5 centimeters is 0.5 centimeter in diameter and soft to palpation. The distal 2 centimeters is represented by a thin fibrous cord 1.5 millimeters in diameter. The serosal surface is rough everywhere, but shows no exudate. When sectioned the lumen of the proximal part is found to be patent and to contain a small amount of bloody material. The distal lumen cannot be entered. The wall of the proximal part is slightly thickened especially near the line of excision.

Microscopic section of the tissue from the edge of the ulcer shows the base of the pyramidal shaped tissue to be composed of fat, the fibrous tissue septa of which are infiltrated with inflammatory cells, a large proportion of which are lymphocytes. There are also a few eosinophiles. Several broad septa are markedly oedematous. As the depths of this fat layer are approached, this cellular infiltration becomes more marked and here a few polymorphonuclears are intermingled with the other cells. The

remainder of the tissue extending from the fat to the tip of the pyramid is more or less alike and consists of very loose oedematous fibrous tissue containing very few fibroblasts and a fair number of young capillaries. It is very heavily infiltrated with polymorphonuclears and some lymphocytes. There is also a moderate number of eosinophiles here, and a few endothelial leucocytes. Many of these cells are necrotic and have pyknotic nuclei and there is considerable nuclear debris sprinkled throughout. Several spots show complete necrosis and take a uniform granular acidophilic stain. There is no indication of the original layers of the cæcum except that near the tip of the pyramidal piece there are again some fat cells embedded in the inflammatory tissue and here are a few arterioles and this might be taken to be the remains of the submucosa. There are no epithelial cells recognizable anywhere and no evidence of carcinoma. No amebæ are found after careful search and there is no evidence of tuberculosis anywhere. There are a few small areas of fresh hæmorrhage, but no old changed hæmoglobin to indicate previous hæmorrhage.

Section of the appendix shows the distal tip to be composed of a mixture of smooth muscle and fibrous tissue with only small knots of lymphocytes. No mucosa is seen anywhere. Proximal to this, the muscularis is thin and fibrosed for a considerable distance although the mucosa is of good thickness. The mucosa here shows considerable eosinophilic infiltration and scattered areas of lymphocytic infiltration are found in the muscularis and serosa. Diagnosis: chronic inflammatory tissue from cæcum chronic obliterative appendicitis.

I felt it would be of considerable interest to ascertain whether there was any interference with the motility of the cæcum as a result of the operation or any gross evidence of pathology in the colon that might be revealed by X-ray studies. Therefore, following discharge from the hospital the patient was advised to have gastro-intestinal studies. The following is the report.

May 13, 1929. There was no obstruction to the passage of the barium enema. The base of the cæcum was slightly dilated. There were no filling defects but a moderate redundant sigmoid.

May 22, 1929. The œsophagus was normal. The stomach occupied a medium position. It appeared to be definitely narrowed near the pyloric end of the stomach but this narrowing is probably due to spasm. The first portion of the duodenum was large but filled normally. At the 6 hour examination the head of the meal was in the distal portion of the transverse colon (normal motility). At 24 hours the large bowel almost completely emptied. Plain films of the gall bladder region showed a slight suggestion of the outline of the gall bladder but no evidence of stones. Plain film of the urinary

tract showed some definite hypertrophic changes in the lumbar spine. There was nothing abnormal noted in the genito urinary tract.

#### SUMMARY

A case of a simple, non specific ulcer of the colon which perforated is reported. The gross and histological characteristics of this ulcer seem to be analagous to that of peptic ulcer, and therefore the question arises as to whether an ulcer occurring on the colon is not a local manifestation of the same general disease that peptic ulcer is. There is nothing in the past or present history of this patient that would suggest the cause to be mechanical, such as a decubital ulcer due to constipation. When the ulcer occurs on the right half of the

colon it is difficult to differentiate this lesion from appendicitis. However, since in the vast majority of cases both conditions require immediate operation it is important to remember that when the appendix appears more or less normal or does not give evidence of a sufficient inflammation to produce the clinical picture, the cecum and the ascending colon should be explored for the possibility of an ulcer.

#### REFERENCES

1. BARRON, M. E. Simple non-specific ulcer of the colon. *Arch. Surg.*, 1928, *xxvii*, 335-407.
2. BOLTON, C. *Ulcer of the Stomach*, pp. 35-36. London: Edward Arnold, 1913.
3. COMBES, C. *Simple ulcer of the intestine*. Thèse de doct., Toulouse, 1891.
4. VIAL, E. Rectum in *Dictionnaire encyclopédique des sciences médicales*, 1874-1881, ii, pp. 6, 8-690.

# CLINICAL SURGERY

FROM THE HESSISCHE HEBIMWIELEHRANSTALT, MAINZ

## THE THEORY AND PRACTICE OF INTRA-UTERINE CHARCOAL TREATMENT IN GYNECOLOGY AND MIDWIFERY

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THE favorable results reported by Benthin of Königsberg, and Geller, of Breslau led us to employ charcoal intra uterinely in gynecological and obstetrical cases and we have been able to obtain the same favorable results as reported by these authors

Before responding to an invitation to test and recommend a new preparation or treatment—especially when good therapeutic procedures are already in existence—one must be convinced of the value of the new method and of its freedom from danger. In particular, one must understand the effect of the preparation—in the present instance, charcoal—and must then consider whether the new method of treatment (intra uterine charcoal treatment) offers any great advantages over methods already available

For the better understanding of intra uterine charcoal treatment I should like to preface my remarks with some brief observations on the importance and advantages of charcoal as a therapeutic agent

The use of charcoal in medicine is probably not uncommon. Even in olden times wounds and internal affections were treated with adsorbent substances. The most important quality of medicinal charcoal is because of its porous structure and consequent great surface energy, its high power of adsorption, i.e., of fixing other substances. To this property charcoal owes its great use. The adsorptive capacity is manifested either in the adsorption of wound secretions or in the adsorption of bacteria and their toxins. The latter is of very great importance.

To gain a clear conception of the processes to which the name of adsorption phenomena is applied it is necessary to have recourse to the department of physical chemistry especially of colloid chemistry in which the phenomena of surface energy are of great importance. I would refer in this connection to the paper<sup>1</sup> by Franz

Koenig on "The Importance of Medicinal Charcoal in Therapeutics and the Nature of Adsorption." In this paper a short sketch is given of the conception and nature of adsorption, and also of the practical employment of charcoal in medicine, i.e., of adsorption therapy. The range of indications of which is very extensive. For us as medical practitioners, these pharmaceutical details are of infinite value in enabling us to obtain for ourselves a satisfactory explanation of the mode of action of the application of charcoal. Adsorption depends upon (1) the extent of the surface energy, i.e., the size of the free surface, (2) the surface tension between adsorbent (charcoal) and liquid and (3) the surface activity of the liquid.

While, as a result of the adsorption of wound secretion it is made much more difficult for bacteria to live on the drained tissue surface, it is true that as a result of the adsorbent fixative action on bacteria and on the poisonous properties of bacterial toxins, adsorption into the blood stream is very greatly retarded, if not rendered altogether impossible. Weidmann has shown that charcoal powder has an adsorbent action even on bacteria in the blood. It is absolutely necessary, therefore, in cases of poisoning for example, that the quantity of charcoal should be sufficient to reduce the quantity of poison present to below the lethal dose. Van Amstel has demonstrated that the maximum dose of charcoal to be administered at once in man is 40 to 50 grams.

In addition to the great adsorptive power just described, the astringent action of charcoal plays a not inconsiderable part.

Is the local application of charcoal likely, it may be asked to produce any injurious or detrimental effects? All the publications on the subject show beyond doubt that this is not the case. Geller and others have proved that no harmful action on the cells appears as the result of the application of charcoal but that, in virtue of the property already mentioned, of abstracting fluid, a stimulant

<sup>1</sup>Pharm. Ztg. 1905 No. 102



action is actually exerted on the tissues, which leads to hyperæmia.

The very fact that charcoal possesses such great therapeutic powers makes necessary especial care in selecting preparations of charcoal for medicinal use, such preparations must be of high standard. It is well known that the ordinary medicinal charcoal preparations on the market show very great differences in adsorptive capacity. The suitability of charcoal preparations for medicinal use is dependent not on the source (animal or vegetable) but solely on the method of treatment of the charcoal.

Up to the present charcoal and, consequently, adsorption therapy have been used only in the treatment of the gastro-intestinal canal diseases such as acute poisoning with metallic salts, poisoning with organic poisons, poisoning produced by meat, fish, sausages, preserved foods, infectious diseases (cholera, dysentery, etc.) and intestinal auto-intoxication, hyperacidity and gastric ulcer (of special value in the latter on account of the acid binding and ferment inhibiting action of charcoal), excessive gas formation (postoperative intestinal paresis) and the presence of large numbers of bacteria. Recently, however, charcoal therapy has been used, by means of intra uterine application in gynecology and obstetrics. Favorable results following the intra uterine application of charcoal in metritis were first reported in veterinary medicine.

In what conditions in human gynecology and obstetrics is the charcoal treatment indicated? In abortion especially febrile abortion, in puerperal endometritis, and in cesarean section after rupture of the membranes. The conservative treatment of septic abortion first inaugurated by Winter, of Koenigsberg is now generally recognized as correct.

The process of recovery is hastened by the intra uterine application of charcoal by reason of the preventive and curative action of the charcoal. The determining factor in the success of the treatment is its application at the earliest possible moment, provided the process is still substantially localized in the uterine cavity and provided sufficient charcoal in the form of granulated charcoal pencils which from the colloid chemical point of view, approximate most closely the ideal powder, is introduced into the cavity of the uterus (insufflation of powdered charcoal is dangerous and therefore unsuitable for use in this treatment). The task of the charcoal thus introduced is to prevent, or at the least render difficult the occurrence of any absorption from the residual fluid of the uterine cavity, heavily charged with bacteria

and toxins, into the tissues or the blood and lymph apparatus. Such absorption, or the entry of the poisonous substances into the cells is prevented or hindered by a protective layer, difficult of penetration, which is formed by the dissolved particles of carbon.

It is necessary to use a quantity of charcoal sufficient, after expansion, to fill the whole cavity of the uterus and to cover the decidua completely. Further bacterial invasion is thereby made impossible.

As already mentioned, it has been demonstrated by Geller that no injury to healthy, regenerated mucous membrane cells occurs as the result of too abundant application of charcoal in the case of a local focus in the uterine cavity.

The germicidal action is, indeed, heightened by the fact that in consequence of the abstraction of water from the tissues, a stimulant effect leading to hyperæmia is simultaneously exerted on the healthy tissues. From these considerations and collected experiences it is sufficiently evident that intra uterine charcoal treatment offers great therapeutic advantages over the measures hitherto generally employed.

With uterine irrigations, a method now only rarely used, we obtain at most a temporary diminution of bacteria. The irrigating fluid is immediately evacuated partly through the return flow catheter, partly through the cervical canal. Its action on the foci of infection is therefore of short duration. There is moreover the danger of injury to the mucous membranes by the rigid catheter. Such injury makes a place of lessened resistance sufficient to enable bacteria to break through the leucocytic defense. A further danger is that the bacteria infested contents of the uterus may be washed upward into the fallopian tubes and possibly into the abdominal cavity.

Swabbing of the uterine cavity with ether and iodine, intravenous infusion of dextrose and tamponage of the infected uterine cavity remain to be mentioned. The latter is supposed to act by absorption and at the same time serve as a means of escape for the uterine contents. Attempts have also been made to fight bacterial infection of the uterus by means of intravenous injections of trypan blue, argochrome and collargol solutions etc. Irradiation of the infected and metritic uterus with X rays has likewise been employed therapeutically. All these methods of treatment are so variable in their results—while some are not wholly free from danger—that none of them can be called fully effective. All have their good and bad points. These factors of danger and variable results do not exist with charcoal therapy.

For charcoal therapy we make use of the pencils of granulated charcoal, measuring 3 and 5 centimeters in length and about 4 to 5 millimeters in thickness, which have been placed at our disposal by E. Merck, of Darmstadt. These pencils, which are prepared from pure, compressed granulated charcoal—laolin is unsuitable on account of its forming lumps—are very convenient in form but are very easily broken. Gentle manipulation is necessary, as indeed is the case in all intra uterine procedures. The fragility of the pencils has at the same time, however, the advantage that the least attempt, during their insertion, to overcome any resistance (narrow cervical canal, acute angled inflexion) by the use of force is met by the immediate breaking of the pencil, so that we are, as it were, debarred from causing injury.

What happens to the pencils in the cavity of the uterus? In the bacteria and toxin laden residual fluid of the uterus they begin to effervesce and to dissolve, at the same time exerting their therapeutic effect (inhibiting bacterial growth). They find themselves in a medium in which their disintegration is complete. That disintegration may, in isolated instances, be incomplete is shown by the fact that fairly large particles of charcoal are sometimes expelled again. Even after the lapse of 10 to 12 days we have found small remnants of charcoal in the posterior vault of the vagina. This fact has no influence on the favorable effects of the treatment. I shall again refer to these processes. The solution of the pencil can be facilitated by dipping it two or three times in distilled water before inserting it. By this means the outer parts of the charcoal pencil are softened and more rapid intermingling of the charcoal with the uterine contents is obtained. The insertion of the moistened pencils demands particularly delicate manipulation as they are very much more fragile, on the other hand by reason of the softened outer covering of charcoal, the possibility of injury and lesions of the mucous membrane is nil from the very beginning.

The processes which attend the interaction between the disintegrating charcoal pencil and the infected uterine fluid can be illustrated by preparing a fluid chemically similar to that contained in the uterus and treating it with the charcoal pencil in a vessel of some sort. To the accompaniment of effervescence and decrepitation, a thick, black pasty mass is produced, in which some solid particles of charcoal may remain undissolved.

In these experiments *in vitro*, which exhibit to us in some measure the intra uterine processes, there is missing however, the action on the charcoal pencil of the uterine contractions, which are

of great value in effecting the solution of the charcoal and its union with the bacteria infected contents of the uterus.

# INDICATIONS

In the remainder of this paper I wish to speak of the range of indications for charcoal therapy and of the technique practiced by us.

Our treatment of abortion is strictly conservative, provided hemorrhages do not call for our interference. We regard every febrile abortion as intentional, produced by external interference. The same may be held true of afebrile cases, only here the operator has proceeded with rather more cleanliness.

In numerous trials we have been able to prove experimentally that the granulated charcoal introduced into the poison containing media (before any toxic action on the tissue appears), prevents their extension and continuance. We speak of a "direct prophylactic action," by means of which many severe affections, and even death, can be avoided. The possibilities of this direct prophylactic action led us to insert one or two charcoal pencils, also in every case of fever free abortion which for any reason had to be actively terminated, always on the supposition that a local infection might be present. This prophylaxis is of still greater and more effective value in those cases which are admitted with temperatures of up to 38 degrees C (100.4 degrees F) and which it is necessary for us to terminate. We found in almost all cases that the temperature fell to normal in at most 24 hours and, what is worthy of note, that convalescence was uninterrupted and entirely free from fever so that it could be assumed that the bacteria in the uterine cavity had been killed. In cases of febrile abortion, there is often during convalescence a subfebrile temperature extending over several days, and indicating in most cases an endometritis. The result of charcoal therapy is to eliminate this temperature and to secure a convalescence free from fever, and its success in this respect is the greater in proportion as the treatment is commenced early, i.e., before toxic damage to the tissues has set in.

There is a further field in which this direct prophylactic intra uterine application of charcoal is indicated—cases of abortion which are admitted to the hospital with high fever and severe local infection. The possibility of securing better results in treating these cases by means of charcoal, is also mentioned by Benthin who suggests that the infected uterine contents be rendered germ-free, or bacterial growth prevented at least, by inserting charcoal pencils as a first measure, before the infected case is actively terminated. In

similar cases we have begun by inserting charcoal pencils, and have been able in 24 hours at most to see whether the desired effect has set in, as evidenced by fall of temperature, improvement in the general condition, and almost immediate cessation of any malodorous discharge that may be present. A critical examination of each individual case must naturally precede treatment, for we can expect to influence the bacteria by means of intra uterine charcoal therapy only when the pathological process is strictly localized in the uterine cavity. After this direct prophylactic preliminary treatment, we can be sure of having a uterine cavity which is in some measure free from bacteria, so that less danger is involved in subsequent active procedures. Cases treated in this way have confirmed in practice our theoretical conclusions. The further course was in all cases free from fever, the fall in temperature critical. In these cases a part is played not only by the adsorbent and astringent action of the charcoal, but also by the charcoal pencil as a foreign body. The uterus reacts with contractions, so that placental remnants which have become purulent are partly detached if not entirely expelled. As soon as detachment occurs the dissolved charcoal can immediately exert its therapeutic powers at the site of adhesion, and so prevent further ascent of the bacteria.

Puerperal metritis is also very favorably influenced by intra uterine charcoal therapy, so that we now include this condition among our indications for the treatment. As soon as evil smelling discharge and subfebrile temperatures set in, the patients are treated for 5 to 6 days with ergotin or gravitol (either 20 drops thrice daily or better, a double dose of one of these medicaments on each of 3 successive days) and with the ice bag the head of the bed is also raised 25 centimeters so as to facilitate escape of the discharge. If no improvement is obtained by these means, we introduce charcoal into the uterus on the seventh day under the strictest aseptic precautions. In all cases a reduction in temperature was obtained on the next day, and on the second day at latest the temperature fell to normal. The fetid odor disappeared at once. In over 90 per cent of the cases it was unnecessary to insert charcoal pencils more than once a fact which says much for this method of treatment. In several cases of pyometra we were able to bring about complete recovery, with lytic fall of temperature only after several applications of charcoal. Even in these cases however, the evil lochial odor—often very unpleasant both to the patient and her neighbors—disappeared immediately after the very first applica-

tion a result which has a considerable influence in improving the patient's general condition.

As a result of our experience, I should like to extend the range of indications still further and include therein a class of cases often complicated by prolonged wound suppuration. These are cases of cesarean section after rupture of the membranes. We cannot know how far an infection of the uterine cavity has taken place. Our statistics of cesarean section for the ten years from 1918 to 1928 showed one abdominal abscess in cases of operation before rupture of the membranes, 10 abdominal abscesses in cases of operation after rupture of the membranes and almost always an endometritis with fever, which in most cases lasted over a week.

Accordingly, in such cases we insert several (3 to 5) granulated charcoal pencils into the uterine cavity after expulsion of the placenta. It is here quite impossible to cause even the slightest injury, as the uterine cavity lies open. I regard this method as the safest way of obtaining local prophylaxis of the uterine cavity. In swabbing with ether, tincture of iodine or dry swabs there is the great danger of transferring bacteria from one part to another.

Prophylaxis against an infection which is still invisible is also in any case a less severe and less dangerous proceeding than the treatment of an evident infection of the endometrium. From this therapy we have as yet seen no disadvantages but only advantages.

We, therefore employ charcoal pencils

1 In cases of infected abortion before or after clearing out, according to the condition of the patient.

2 In cases of puerperal endometritis—not before the seventh day of the puerperium.

3 Prophylactically, in cases of cesarean section after rupture of the membranes.

#### TECHNIQUE

The technique of intra uterine charcoal therapy is very simple. The necessary instruments (2 specula, 1 hooked forceps, 1 bullet forceps and 1 long tweezers) are previously boiled before insertion of the specula the orifice of the vagina is cleansed and then the vagina washed out with aluminium acetate. The portio vaginalis is exposed and the anterior lip of the os uteri hooked. The external os uteri is cleansed from mucus and blood. The charcoal pencil is grasped at one end with a dressing forceps dipped two or three times in sterile water and then carefully inserted through the cervical canal to beyond the internal os uteri. The cervical canal is almost always so

wide open that the charcoal pencil can be introduced without difficulty. We do not agree with Benthin in his recommendation of dilatation when the os uteri is occluded. According to the severity of the case and the size of the uterine cavity, two or three pencils may be introduced, and then distributed in the cavity, the first more toward the right, the second more toward the left tubal angle, and a third if necessary in the middle. Generally, however, one pencil of 3 centimeters in length is sufficient. After removal of the dressing forceps one hears the crackling and effervescence already mentioned as taking place when the charcoal pencil fixes the uterine contents. The crushing and mixing of the charcoal are greatly assisted by the muscular contractions which, as previously noted, are produced by the charcoal pencil in its capacity as a foreign body. In order to prevent immediate escape of the charcoal paste or foam through the cervical canal a thin strip of gauze is placed in the cervix with one end projecting from the vaginal orifice. After the lapse of 3 to 4 hours the gauze is withdrawn, and it can then be assumed with safety that intermixture of the charcoal and the uterine contents is complete, and that the walls of the uterine cavity have become covered with the charcoal suspension. As I have already mentioned, comparatively large particles of charcoal are found in some cases in the posterior vaginal vault. The undissolved portions of charcoal are expelled by the uterine contractions. The fact that fairly large particles of charcoal may remain undissolved is capable of explanation as follows: (1) there may be an excess of charcoal in proportion to the size of the uterine cavity, i. e., the uterine contents are saturated; (2) some parts of the charcoal pencil may be too strongly compressed or may be lying more in the cervical portion of the uterus and so cannot be completely dissolved by the bacteria containing residual fluid. An excess in the amount of charcoal introduced is never to the disadvantage of the treatment, as one can then be sure that the whole uterine cavity is uniformly filled, i. e. is lined with a coating of charcoal capable of exerting an adequate adsorptive action. The thicker the wall represented by this coating the greater will be its fixing effect.

To the details already given I would add that those of our cases which come within the indications mentioned have not simply been subjected to treatment with charcoal alone. In many cases naturally our previous methods of treatment have had to give way to charcoal therapy to enable us to get an accurate view of the effects of the application of charcoal alone. The cases thus

treated almost all led to the desired result. We have, indeed, obtained the impression that we considerably shortened convalescence without detriment to the premanence of the recovery. When we were in position to judge the results of charcoal treatment alone, we assisted the process of healing by means of ergotin or gravitol and the ice bag. The decisive factor in bringing about the rapid and favorable results, however, was the charcoal alone.

Unlike Benthin we have not strictly limited our range of indications, but have tried to obtain conclusive proof in as wide a variety of cases as possible, of the great therapeutic powers lying dormant in charcoal. Our observations give us ground for placing our favorable results on a level, in every respect with those of Benthin and Geller. These authors conclude their discussion with an appeal for further testing of the method. I should not like to close my paper without repeating this appeal for critical consideration of the results obtained shows the treatment to be worthy of trial. Everything new, however, is met with a certain skepticism. "Warum denn in die Ferne schweifen, wenn das Gute liegt so nah!" Why should I still further overload a sick body with high molecular intravenous solutions, why should I wash or swab out the cavity of the uterus and thereby run the risk of producing injuries or of facilitating a further ascent of the pathological process? The reported results of the charcoal treatment both in human and in veterinary medicine, are so favorable that they cannot be rejected at once with a decisive "No." The intra-uterine application of charcoal is completely free from danger, the medicament is very cheap and the period of illness is greatly shortened. The symptoms are instantaneously influenced, never for the worse. The body responds with an immediate improvement in the patient's general condition and in the local process with a fall in temperature and in the pulse rate.

#### INTRAVENOUS CHARCOAL THERAPY

What I have said so far relates only to local—intra-uterine—charcoal treatment. I should like now within the framework of this paper, to touch upon the subject of intravenous charcoal therapy. This first came into use simultaneously with the intra-uterine treatment, in veterinary medicine.

A suspension of charcoal was injected intravenously in septic affections. This intravenous application of charcoal was first adopted in human

\* Why then go abroad seeking afar when the good lies close at hand.

medicine—and with very good results—by Wedekind, at the I Medical Clinic University of Cologne (Prof Kuelbs), for the purpose of actively attacking tuberculosis. In his summary, Wedekind says "By the intravenous administration of very small amounts of charcoal dust, even severe exudative and proliferative forms of human pulmonary tuberculosis can be brought in a short time to induration. A pre requisite for this form of therapy is that too great portions of the lungs should not already have undergone ulcerative disintegration, and that the body should still be capable of reaction. Relatively recent processes are most capable of recovery."

"No aggravations attributable to the treatment were ever manifest. Symptoms of intoxication did not appear. This influence of charcoal dust on the course of tuberculosis is explained by the activation of the reticulo-endothelial defensive apparatus which it produces, and in particular by the mobilization of the connective tissue histocytes of the lungs."

Another very interesting anatomico-physiological study of the action of intravenous charcoal therapy in pulmonary tuberculosis is one by H. Gickler, which appeared in the *Beitraege zur Klinik der Tuberkulose*.

I have purposely referred to these papers in some detail because in part they provided us with factors for comparison with the observations made by us in the intravenous application of charcoal in sepsis, and in part gave us an explanation of processes which are exceedingly important in the problem of the treatment of sepsis. As I have here touched on the subject of sepsis, I should like to mention the paper published by Louros and Scheyer on "streptococcal infections, the reticulo-endothelial system, their relations and their amenability to therapy." The two authors sum up their very interesting observations as follows: "From the investigations described it appears that in animal experiments it is possible by means of injections of charcoal to exert a favorable in-

fluence on the outcome of a streptococcal infection, in one third of the cases, this result being attained by way of a general improvement in the functioning of the reticulo-endothelial system and in particular by a heightening of the phagocytic activity of the reticulo-endothelial system, especially toward introduced bacteria. The charcoal acts first by altering the hydrogen ion concentration of the media in the direction of an acidity which checks bacterial growth (Dresel). The charcoal then exerts its chief action as an adsorbent and serves as a vehicle for the bacteria to the phagocytosis of which it stimulates mechanically the reticulo-endothelial system. The action is to be regarded as purely non specific, and appears to be particularly favorable by reason of the fact that the mechanical stimulant effect on the reticulo-endothelial system is combined with the physical phenomenon of adsorption and with the physico-chemical phenomenon of alteration of the hydrogen ion concentration."

So far as our experiments and experiences up to the present, in the intravenous charcoal treatment of sepsis allow of comparison, we can say that much valuable investigation can still be done in this department. At all events, the cases of sepsis which we have so far treated in this way have provided us with a plan of work, for the carrying out of which a large number of interesting experiments of very varied nature are necessary, some of these representing in themselves a complete field of work. We shall report on these matters elsewhere.

#### REFERENCES

- BENTZEN, W. *Zentralbl f Gynaek* 1923 p 14.  
 GELLER, F. C. *Zentralbl f Gynaek* 1926 p 3 1929 p 2.  
 GICKLER, H. *Beitr z klin Tuberk*.  
 GRAF, H. *Deutsche tierärztliche Wochenschr* 1923 p 43.  
 KOENIG, G. *Pharm Ztg* 1926 p 40 1925 p 101.  
 LOUROS, N. and SCHEYER, H. E. *Ztschr f d. ges. exper. Med* vol IV part 5-6.  
 MERCK, E. *Pharm Ztg* 1924 p 44.  
 WEDEKIND, T. *Deutsche Arch f klin. Med* vol. clxxx part 3-4.

## FROM THE SURGICAL CLINIC, STATE UNIVERSITY AT KASAN

LOCAL ANÆSTHESIA IN ABDOMINAL SURGERY<sup>1</sup>

PROFESSOR ALEXANDER W. WISHNIEWSKY KASAN U. S. S. R.

Direct. of the Surgical Clinic

I BELIEVE that the ideal anæsthesia in surgery will be that which will cause the patient's organism no insult outside of the operative field. Local infiltration anæsthesia comes closest to this ideal. However, the classical infiltration anæsthesia of Reclus with the concentrated solutions of cocaine could not be accepted as harmless for the organism. Work with concentrated solutions is based upon the principle of osmosis and diffusion and in this respect the solutions are not constant in their effect. This fact has contributed greatly toward the disrepute in which infiltration anæsthesia has fallen and even the brilliant investigations of Braun who introduced novocain and adrenalin in local anæsthesia have helped little to make popular such means of inducing anæsthesia.

My method of inducing local anæsthesia consists in the injecting, layer by layer of large quantities of a 1 per cent solution of novocain in Ringer's solution from which bicarbonate of soda is removed with the addition of 2 minims of adrenalin to each 100 cubic centimeters of solution. Large amounts of solution are used for injection into the various anatomical layers of the operative field as a result large serpentine anastomosing infiltrations are formed which block the nerves by direct contact and pressure rather than by diffusion. Occasionally the solution is injected slightly away from the immediate operative field but always close to it. The tissues may be incised immediately upon injection without the need of waiting for diffusion of the drug.

No single one of all the various methods of local anæsthesia is applicable to all types of surgical operations within the abdominal cavity. It is true that local anæsthesia is frequently used in performing complicated surgical procedures in the peritoneal cavity. However there is no single well systematized method of inducing local anæsthesia that may be used in all major operations within the abdomen. Mikulicz and Schleich introduced the method of using infiltration anæsthesia for the abdominal wall but after the peritoneal cavity was opened they continued the operation without further anæsthesia. Finsterer, Farr and others suggested that mesentery and

ligaments which are to be handled during the operation be anæsthetized by means of injections of novocain. Laewen and Siegel worked out the technique of paravertebral anæsthesia, while Kappis and Braun that for splanchnic anæsthesia. The latter method has become popular although nitrous oxide is used with it.

I shall describe here the method of local anæsthesia which is being used in my clinic in abdominal surgery. My method is a further development of a combination of infiltration anæsthesia and mesenteric anæsthesia. That local anæsthesia by injection into the mesentery as suggested by Farr and Finsterer is far from being satisfactory is easily seen from the difficulties usually encountered in its use. I have witnessed situations in which the surgeon is lost in an effort to locate a point for the injection of the novocain into the mesentery, and each time the needle was inserted the surgeon ran the risk of puncturing a blood vessel. Years ago I had the same difficulties but of course, with growing experience I have learned to master such situations. However, I have been struck by the fact that the technique used for this type of anæsthesia is purely casual in character and that the method of procedure is without system or definite plan. The results of my surgical work changed radically after I worked out systematically the details of producing local anæsthesia, and I wish to describe here the technique I have worked out in producing anæsthesia in relation to the various important abdominal organs.

## TECHNIQUE

*The stomach.* I shall consider here the method of producing anæsthesia in a patient requiring resection of the stomach. Such an operation is a supreme test not only because of the difficulty of the operation itself but because of the condition of the patient.

1. The midline along the proposed line of incision is infiltrated with novocain after which the subcutaneous layer is infiltrated. Infiltration must be sufficient to cause a true swelling of about two fingers breadth since only then will the anæsthesia be effective for a period of about 3 hours. The incision is made and the midline dissected (Fig. 1).

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#### REFERENCES

- BENTHEIM W. *Zentralbl f Gynaek.* 1928 p 24.  
 GELLER F C. *Zentralbl f Gynaek.* 1926 p 3, 1929 p 7.  
 GICKLER H. *Beitr z klin Tuberk.*  
 GRAF H. *Deutsche tierärztliche Wochenschr.* 1928 p 43.  
 KOENIG F. *Pharm Ztg.* 1926 p 42, 1928 p 101.  
 LOUROS N. and SCHIEVER H E. *Ztschr f d. ges. exper. Med.* vol. 44 part 5-6.  
 MERCK E. *Pharm Ztg.* 1924 p 44.  
 WEDKIND T. *Deutsche Arch. f. klin. Med.* vol. clxxxv part 3 4.

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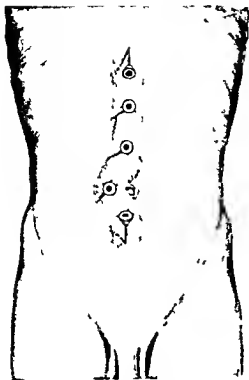


Fig 1

2 The midline is then injected in such a way as to infiltrate the preperitoneal fat. It is essential to direct the needle under the anterior sheath of the rectus muscle on either side of the midline.

3 After the incision of the midline the parietal peritoneum is anesthetized. The preperitoneal tissues are retracted and novocain is injected about the parietal peritoneum and especially into the posterior sheaths of the recti on either side (Fig 2).

4 The peritoneum is incised and the transverse colon is delivered into the wound turned up, and the inferior surface of its mesentery exposed. An avascular point close to the root of the mesentery is chosen for the first injection. The subsequent injections are so made into the borders of the area which has become oedematous from the first injection that on one side the injected fluid spreads behind the posterior parietal peritoneum downward toward the root of the mesentery of the small intestines, and on the other side expands throughout the root of the mesocolon thus separating both leaves of the peritoneum and extending upward toward the peritoneal envelope (serosa) of the duodenum (Fig 3). The spreading of the fluid toward the root of the mesentery of

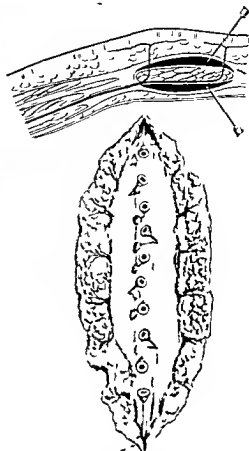


Fig 2

the small intestines makes it essential to keep the intestines out of the way; this point is not taken care of in the usual method of administering splanchnic anesthesia. When the transverse colon is turned downward at this stage of the procedure the oedema caused by the injection is easily seen; this oedema is shimmering through the superior peritoneal leaf of the mesocolon especially on the right side where it is not covered by the gastrosplenic ligament. Supplementary injections into the borders of these oedematous areas are easily made and the danger of puncturing a blood vessel is avoided. As a result the duodenum is bathed so to say in the injected fluid which readily spread beneath its serosa (Fig 4). The mesentery of the stomach is then injected along its lesser curvature in a direction toward the cardia. The gastrosplenic ligament is divided and immediately the upper leaf of the mesocolon comes into view. Several more injections are made here and the fluid



Fig 3

gradually expands toward the pancreas and appears behind the parietal peritoneum at the level of the lesser curvature. Finally the plica gastropancreatica and the gastrosplenic ligament are infiltrated. It is now possible to perform any variety of resection of the stomach (Fig 5).

**Bile ducts.** The principles described under the my method of administering local anæsthesia in surgery of the bile ducts. The novocain is so injected that infiltration is extensive and rapidly spreads along exact anatomical paths. An oblique subcostal incision is made after injection of the abdominal wall in layers. The parietal peritoneum is anesthetized the injection being started well beyond the line of incision. The transverse colon

is delivered and the right half of its mesentery from the root to the periphery is injected. The colon is then turned forward and downward. By pulling down the hepatic flexure slightly, one can easily see between the leaves of the mesocolon the injected fluid spreading toward the posterior abdominal wall. One continuous injection is made into the margins of the oedematous area until the free edge of the hepatoduodenal ligament becomes infiltrated. Then the colon and omentum are replaced in the abdominal cavity, a large gauze pad directed toward the kidney is inserted to pack off the intestines, and the injection of the gall bladder proper is begun.

If the gall bladder has an anatomically intact

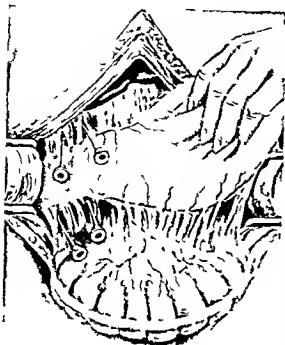


Fig. 4

serosa, a subserous injection of the solution is made until the fluid is seen to have spread toward the ducts and there to have joined the edema caused by the previous injections of the hepatoduodenal ligament. The injected fluid easily separates the gall bladder from its liver bed. Such an injection contributes greatly to the ease with which a subserous cholecystectomy is accomplished. If the gall bladder is shrunken, scarred or tensely packed with stones, one is forced to fall back upon scattered individual small point injections, even though the field of the ducts proper remains completely anesthetized from the previous systematic serpentine injections (Fig. 6).

**Spleen.** A freely movable spleen without adhesions can be easily removed after the line of incision through the abdominal wall has been anesthetized, but when the spleen is adherent it is necessary to administer a strictly systematic anesthesia, not unlike that used for operations on the stomach and bile ducts. After the abdominal cavity is opened through a left oblique subcostal incision, the left half of the mesentery of the transverse colon is anesthetized in the fashion outlined. A portion of the gastrosplenic ligament just sufficient to allow approach to the

upper leaf of the mesocolon is divided. After this section is thoroughly anesthetized the gastrosplenic ligament on the left side is attacked in the same way. Occasionally one will have to inject separately adhesions between the spleen and the diaphragm. That this method is practicable I have been convinced since it has proved successful in my last ten consecutive splenectomies.

**Large intestines.** I know of no report in the literature of a complete removal of the large bowels under intra abdominal local anesthesia. I have used the principle of the serpentine injections in administering local anesthesia in two patients in whom complete removal of the large intestines was considered indicated. The technique may be described as follows. After a mid line incision is made, the transverse colon is delivered and its mesentery is injected as already outlined. The fluid is directed widely behind the posterior parietal peritoneum toward the root of the mesentery of the small intestines. This mesentery is then completely anesthetized by means of additional injections. The small intestines are then delivered from the peritoneal cavity, retracted to the left, and the cæcum and ascending colon are exposed. The mesenteries of the cæcum and ascending colon are injected in the same systematic way. An incision in the peritoneum is then made near the root of the cæcum and the removal of the bowel is commenced. This removal of the bowel is performed gradually in steps so that repair of the defect in the parietal peritoneum immediately follows upon the division of the mesentery in the given region. Before the splenic flexure is approached the small intestines are turned to the right and the descending colon is anesthetized in the usual manner.

In both patients a complete removal of the large intestines was done. Both stood the operation well and left the operating table with a pulse of 70 to 72. The postoperative course was free from complication with one exception—a transient physiological diarrhoea. Both patients were previously operated upon repeatedly for a diffuse ulcerative colitis. Attempts at short-circuiting did not affect the patients' condition and they remained bedridden until complete colectomy was done. At present the patients are in perfect health. I am emphasizing the fact that the small intestines remain without the peritoneal cavity during the entire removal of the colon.

**Pelvic organs.** My method of producing local anesthesia by means of large serpentine anastomosing infiltrations is perfectly applicable in gynecology. Here anesthesia is begun by the formation of extensive infiltration along the an-

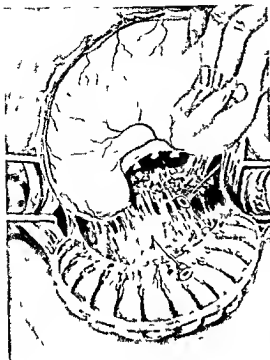


Fig 5

terior aspect of the sacrum. This infiltration is of no blocking importance in the sense of Braun's parasacral anesthesia, when one has to seek each individual sacral foramen. This infiltration is caused merely for future anastomosis with the infiltrations made along the promontory and the innominate pelvic line. To produce presacral infiltration the injection is begun in the midline about 1 inch posterior to the anus. Immediately after the needle is inserted the fluid is slowly injected the needle being gradually moved toward the anterior aspect of the sacrum. The solution easily finds a line of cleavage through which it spreads in front of the sacrum. I inject here about 300 cubic centimeters of the novocain preparation. The anesthesia of the abdominal wall of the parietal peritoneum and in case of adhesions of a small portion of the adjoining intestinal mesentery, is done in the manner outlined. Occasionally the round and broad ligaments may need supplementary injection.

#### SUMMARY AND CONCLUSIONS

It is apparent that my method of producing local anesthesia consists in a blocking of the nerve plexus the blocking being begun in the periphery



Fig 6

and being gradually extended toward the centers. Of course during the operation the anesthetic may spread toward the ganglions but it never suddenly encroaches upon them. This fact contributes much to the physiological safety of the method. The method has all the advantages of splanchnic anesthesia without any of its disadvantages. It is not aggressive, it is technically easy, it can be used in the upper abdomen through any abdominal incision and even in the obese patient is practicable. It requires no general anesthesia and it is not followed by a fall in the blood pressure. However this method differs from direct intra abdominal anesthesia in which the anesthesia is carried along separate spheres of action or along the mesenteric vessels, methods which reflect and depend upon the intuition and experience of the individual surgeon, but which lack exact systematic performance.

This method of local anesthesia based upon the use of large amounts of solution of novocain for the production of serpentine anastomosing infiltrations along anatomical layers leads to an immediate blocking of all the nerves coming in

direct contact with the solution. One is not forced to postpone the incision, awaiting the "diffusion" of the solution to the nerve trunks.

Because of the weakness of the solution of novocain, because of the gradual injection during the entire surgical operation, and especially because of the immediate incision and spontaneous removal of the injected fluid, no danger of intoxication is seen in this method of inducing local anæsthesia. The systematic injection of the solution layer by layer, contributes greatly to the ease of orientation in the anatomical structure of

the organs handled, as, for example the dissection of the gall bladder from the surrounding structures, the freeing of the adherent appendix, etc.

The co-operation of the patient is, of course a prerequisite in this method of anæsthesia and therefore the technique is contra indicated in children and in semiconscious patients. Other contra indications are suppurative conditions of the abdomen. In all other instances this method of inducing local anæsthesia has proved practicable and reliable during the years of its employment in my clinic.

## THE OPERATIVE TREATMENT OF UNUNITED FRACTURE OF THE NECK OF THE FEMUR

ROYAL WHITMAN M.D. F.A.C.S. NEW YORK

I HAVE read with interest and pleasure Dr Albee's paper<sup>1</sup> on the treatment of ununited fracture of the neck of the femur, particularly because of his unqualified endorsement of the abduction method and because it is evident that he no longer favors the immediate open operation, still employed on various pretexts by certain surgeons. I agree with him that in cases of ununited fracture in which the fragments retain a fairly normal contour, the autogenous bone graft operation, of which he is the leading exponent, offers the best assurance of union.

There remains then for discussion only the third and at the present time much more important class in which, because of destruction of bone the restoration of an approximately normal relation is impracticable. In the treatment of this group leaving out of consideration the palliative bifurcation operation of Lorenz there are practically speaking but two alternatives: the reconstruction operation and the procedure employed by Dr Albee.

The reconstruction operation was first performed in 1916 but was not described until 3 years later.<sup>2</sup> Its design was to provide a secure support in locomotion and to restore as far as possible normal muscular control. An improvised neck was constructed by utilizing the bearing sur-

face obtained by removing the trochanter at its base, and leverage was restored by transplanting it with its attached muscles to the outer side of the femur at such tension as would assure security of the joint (Figs. 1 and 2).

In this paper the various procedures then at command were compared from the functional standpoint, including that of Dr Albee which had been described in 1919 in his 'Orthopedic and Reconstruction Surgery.' From these diagrams it will appear that the trochanter was separated only sufficiently to permit the introduction of the upper extremity of the femur to the acetabulum (Fig. 4).

Its development to a physiological bone lever did not appear until 6 years later<sup>3</sup> and a further modification is presented in his last paper (Figs. 5, 6, 7, and 8).

It may be noted that the figure of 1919 presents no indication of a design to increase leverage and shows a narrow and irregular articulating extremity while that of 1929 is smooth and bulbous. It would seem that the functional results of the

J. Am. M. Ass. 49: 58

<sup>1</sup>Albee: *Fred H. Surg. Gynec. & Obst.* 1929, XLIX, 810.  
<sup>2</sup>Whitman: *Royal Surg. Gynec. & Obst.* 1921, XLII, 479.



Fig. 1. left. The condition in ununited fracture of the neck of the femur in which the neck has entirely disappeared.

Fig. 2. The new bearing surface provided by removing the trochanter and transplanting it lower down on the shaft. (Figs. 1 and 2 from *Surg. Gynec. & Obst.* 1921 June.)



Fig. 3. A final result of the reconstruction operation.

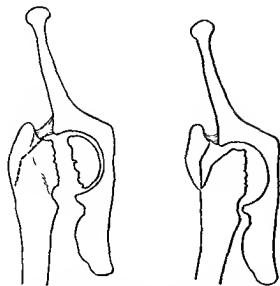


Fig 4 Old ununited fracture of the neck of the femur with erosion of most of head and neck and with marked osteoporosis of the remaining shell of the head. The trochanter is separated with osteotome as shown by dotted lines in figure at left and is forced outward with the overlying soft structures below as a hinge. The removal of the head then allows the neck to be displaced into the acetabulum (Albee *Orthopedic and Reconstruction Surgery* 1919)

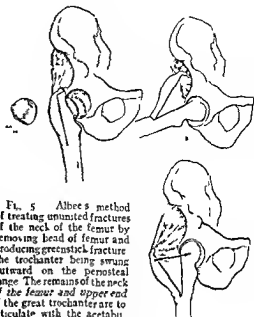


Fig. 5 Albee's method of treating ununited fractures of the neck of the femur by removing head of femur and producing greenstick fracture the trochanter being swung upward on the periosteal hinge. The remains of the neck of the femur and upper end of the great trochanter are to articulate with the acetabulum the inserted portion of the capsular ligament contributing to the formation of the new articulation (Albee *J Am M Ass* 1913). As contrasted with the original this illustrates the evolution of the physiological lever

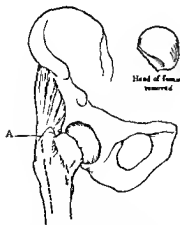


Fig 6

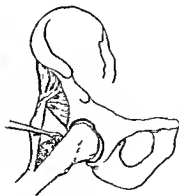


Fig 7

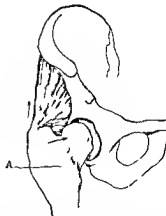


Fig 8

Fig 6 Schematic drawing of author's reconstruction operation with removal of femoral head. dotted line indicates bone's action of upper end of femur by broad osteotome

Fig 7 Displacement of upper end of bone muscle lever outward by abduction of hip which automatically thrusts the new femoral head into the acetabulum at the

same time holding the bone muscle lever in of lique relation to the shaft. The angle is then filled with cancellous bone material from greater trochanter as indicated

Fig 8 Drawing from X-ray film showing consolidation of union of bone muscle lever with main portion of femur angle being filled in at Albee *Surg Gynec & Obst* 1929

operation as performed in 1929 must differ materially from those obtained in the earlier cases, but no distinction is made in the table of statistics.

Dr Albee states that "his operation is the simplest yet devised" yet it entails stripping the muscles from the ilium over a large area and splitting off a wide section of bone from the femur. This is then forced outward leaving a triangular space approximately 4 by 3 inches to be filled by prospective bone formation.

The reconstruction operation by contrast has not been changed in any essential since its introduction. It has the advantage of simplicity of design, directness of approach, and definiteness of execution. There is no division of muscles, the anatomical adjustments are completed at the time of operation and are therefore independent of the nutritive processes on which Dr Albee counts to assure the stability of the lever.

A final point at issue is that of nomenclature since Dr Albee claims the same name for his operation.

It seems to me that the reconstruction operation justifies its title not merely by priority but by design and accomplishment, while in both particulars Dr Albee's operation presents a complete divergence from the natural construction. I suggest, therefore, in order to avoid confusion, that it be designated by one of its subsidiary titles, preferably the 'physiological bone lever operation' which will indicate the essential distinction between the alternative procedures.



Fig 9 Result after bone muscle lever has united in place illustrating the wide distance between the great trochanter and the side of the pelvis in proximity to the rim of the acetabulum thus allowing for generous abduction (Albee 1925). This illustration shows the actual condition far more clearly than the somewhat fanciful diagrams, particularly the shape and area of the bearing surface. Furthermore, that the displaced trochanter is relatively elevated lessening the distance between the origin and attachment of the abductor muscles and therefore their leverage. Contrast with Fig 3.



## THE USE OF IODIZED OIL (LIPIODOL AND IODIPIN) IN THE DIAGNOSIS OF JOINT LESIONS

PHILIP H. KREUSCHER M.D. F.A.C.S. AND H. KELIKIAN M.D., CHICAGO

THE value of iodized oil in the diagnostic visualization of bronchiectatic cavities and spinal canals is well recognized. It has occurred to us that because it is non-toxic, non-irritating and shows a splendid shadow on the X-ray film, iodized oil should be suitable for a similar purpose in major joints. With this in mind, we have used it in several of the major joints especially the knee and hip joints. Valuable information is obtained concerning the conformation of the joint cavity, its capacity, the communication with bursa and with other diseased processes in the joint or communicating with it. Such pathological changes as hypertrophy of the synovial membrane, destruction or adhesions of the synovial capsule, erosions of the articular cartilage, and cavitations into adjacent bones may be well demonstrated by the use of iodized oil injections followed by immediate and subsequent roentgenographs.

It is interesting to note that in the various types of arthritis in which one would expect the joint cavities to be large and contain a large quantity of oil, they will contain only a small

portion because of the partial obliteration of the synovial pouch. The more nearly normal the joint the more evenly is the oil distributed. Patchy distribution indicates pathology. In one of our hypertrophic cases 100 cubic centimeters was injected into the knee joint without producing undue distention or excessive pain (Fig. 9, Case 5).

The technique of the injection of the knee joint is very much the same as for injection of any other material. A point is selected on the outer side of the knee about 1 inch above the external lateral aspect of the patella. Through a small puncture opening in the skin the needle is inserted under the patella into the joint cavity. Any fluid which may be in the joint is completely aspirated with an aspirating syringe. The warm iodized oil is then injected until the capsule is completely distended. Whenever possible the injection should be made without general anesthesia. A roentgenogram is taken immediately after the injection. The films thus taken antero-posteriorly and laterally show the oil in the various recesses of the free joint cavity. After manipu-



Fig. 1

Fig. 2

Fig. 1. Atrophic arthritis. Note the limited extent of joint capsule filling due to synovial adhesions. (Case 1, Mr. H. W.)

Fig. 2. Shows filling of joint in Case 1 after a second injection 3 months after first injection. The patient had been treated by immobilization, diathermy and amygdalotomies.



Fig. 3

Fig. 4

Fig. 3. Hypertrophic arthritis showing shadow of iodized oil in the joint cavity with the popliteal bursa partially filled immediately after injection in Case 3.

Fig. 4. Film 15 minutes after injection and following flexion and extension exercises of the knee. Note complete filling of popliteal bursa, also point of exit of the bursa into the synovial pouch. Iodized oil shadow is limited by the intact synovial sac. (Case 3.)



Fig 5

Fig 6



Fig 7

Fig 8

Fig 5 E A tuberculous of knee joint before injection showing cavitations into both tuberosities of the tibia (Case 4)

Fig 6 Film immediately after injection showing large popliteal compartment of the synovial sac and tongue like projections of the oil into small cavity in tuberosity of the tibia (Case 4)

Fig 7 Partially filled cavitations in the tibia (Case 4)

Fig 8 Two weeks after injection The oil has escaped from the diseased synovial sac along the tendon sheath of the quadriceps hamstrings and gastrocnemius This is the probable route of exit of infection from the joint into the surrounding tissues giving the pen articular swelling and infiltration seen in many acute and subacute cases (Case 4)

ulation of the joint another film may be made to show the passage of oil into other portions of the synovial pouch and occasionally into bursae (Fig 4)

It was found in one of our cases that the iodized oil had penetrated the synovial capsule and had passed into the tendon sheath of the quadriceps extensor (Fig 8) We believe that the oil finds its way out through the synovial capsule because of synovial erosions It has occurred to us that this is probably the route of extension of infection from the joint and that we may, in this way, explain the tendon sheath thickening and peri articular induration which is seen in so many cases of acute or subacute arthritis

For the injection of the hip joint a point is selected one inch below the tip of the greater trochanter and just anterior to it The needle is introduced and follows along the neck of the femur until a definite obstruction is reached This is the head of the femur The needle is slightly withdrawn, pointed sharply anteriorly and directly into the joint cavity

We have injected the knee joint in 7 cases and

the hip joint in 3 Roentgenograms of some of these are shown

In Case 5 a very faint shadow of the popliteal bursa is visualized The oil had not penetrated the bursa sufficiently to outline it This is undoubtedly due to the fact that synovial fluid so filled the bursa that the oil could not immediately pass into it In those cases in which the bursa is at no time visualized, we have reason to believe that the bursal sac is either entirely obliterated or does not communicate with the free joint cavity

Five days after injection a synovectomy was done in this case The synovia was greatly thickened and studded with papillary formations and villous growths Much of the iodized oil was free in the joint We were much interested to know to what extent the oil had invaded this thickened synovial membrane as this might have a definite bearing on the therapeutic value of the injections in infected joints The report by the pathologist Dr Hueper reads as follows 'In sections with Sudan III stained fat droplets are seen adherent to the surface and in the intercellular spaces of



Fig 9



Fig 10



Fig 11

Fig 9 Extensive synovial hypertrophy Joint injected with 200 cubic centimeters iodized oil Showing the enormous distention of the suprapatellar pouch divided into two separate compartments (Case 5 M S)

Fig 10 Lateral view showing distention of synovial pouch and a faint outline of a very large popliteal bursa (Case 5) At operation the bursa was found greatly enlarged with thickened walls and full of a straw colored fluid

the loose connective tissue and between the fibrils of the strong fibrous tissue Fat droplets were also found in the lymphatics of the deeper layers"

Through a small opening in the popliteal space the popliteal bursa was exposed and completely removed The walls were greatly thickened and infiltrated The lumen was small and completely filled with the same type of fluid which had been aspirated from the joint cavity, but very few oil globules were seen This bears out our contention

the same as that which had been aspirated from the joint Oil could not enter into the bursa because of presence of this fluid

Fig 11 (Case 6) Synovial tuberculosis of the hip joint Note partial filling of hip joint and the reflux of iodized oil into a portion of the tuberculous subtrochanteric bursa the major part of which had been removed by operation

that the presence of the fluid would not permit the oil to find its way into the bursa

Clinically, beneficial effects have been derived from these injections of antiseptic oil into the joints in the majority of our cases Freedom of action of the joint and relief of pain have been reported by the patients

The results from this preliminary clinical investigation have been so gratifying that we feel fully justified in continuing these injections both for the purpose of diagnosis and therapy

THE OPERATIVE TREATMENT OF EMBOLISM OF THE LUNGS<sup>1</sup>

PROF. DR. A. W. MEYER, BERLIN, GERMANY

From the City Hospital of Berlin Charlottenburg—Krankenhaus W. 2

IN Germany, the treatment of embolism of the lungs has interested physicians ever since the days of our surgical genius, Trendelenburg. But since Kirschner's first and only success (in 1924) the treatment has resulted only in failure. Quite recently a number of patients have been saved and it is of these that I wish to write.

Embolism of the lungs is a sort of Damoclean sword, which, unfortunately, threatens every patient who must lie in bed inactive for shorter or longer periods of time. It is not fully realized that such sudden emboli of the lungs occur not only after operation by a surgeon or a gynecologist, but that death from embolism of the lungs is just as frequent in the clinics for internal diseases if one may be permitted to use the word frequent at all in speaking of embolism of the lungs. It was only since we began to study this strange and so often fatal sickness (thrombosis and embolism) that this fact became plain.

In the municipal hospital, Charlottenburg Westend we wished to perform on a dead body an operation for embolism of the lungs, and while in one whole month, the surgical service, which has 500 beds, did not lose one patient from embolism the medical service, which has the same number of beds, lost 7 patients. This should be of interest to all physicians, as well as operating surgeons.

Since we have no sure means of avoiding a thrombosis and embolism, we are unfortunately certain to be confronted again and again with the severest cases of embolism and faced with the decisive question: Shall we wait or not? Will the embolism be overcome? Is it one, anyhow? Shall we undertake the operation for embolism of the lungs? The severest symptoms of embolism can of course abate of themselves and several times I have waited for hours by the bedside of a patient suffering from an embolus, everything prepared and ready and fortunately did not need to operate. It is said that it is very difficult to know when to operate and when not. One who has closely studied patients with this sickness, and who has watched the effects of treatment, devoting himself wholeheartedly to the work, giving of his time and patience—such a man finds it easy to decide when to operate. The patient simply begins to die! And when the man of real experience sees that the patient is dying, he knows that it is

right and proper to operate for embolism of the lungs. It is difficult to characterize the indications for an operation for embolism of the lungs any better; it is not a thing that can be described.

The decision to operate must be made as quick as lightning in the sudden cases, but more time may be used in the chronic, spasmodic cases of embolism. Once operation is decided upon I would advise the following procedure:

In 1908, Trendelenburg proposed that lung emboli be removed from the pulmonary artery. The steps of his procedure are: A T shaped incision of the skin above the left rim of the sternum and the second rib, resection of the second rib whereby the pleura is at once laid bare, section through the cartilage of third rib, and incision of the pericardium. After the pericardium is laid open a sound is passed around the great vessels (aorta and pulmonary artery) which are confluent and arise from the base of the heart. The Trendelenburg sound, which has a bayonet closure, must be connected with a rubber tube. The tube must be drawn through and around the vessels, which can now be drawn forward and strangled. According to the experiences of Trendelenburg, the period of strangulation may be 45 seconds but not more. The pulmonary artery is incised; the emboli are extracted from both large branches; a clip is applied on the side of the pulmonary artery, whereby the slit in the artery is squeezed together and it becomes possible to place the sutures above the clip. With this original Trendelenburg method of operation, Kirschner in 1924 saved the life of a patient, a woman of 38 years and was thus the first to demonstrate that this bold and splendid procedure could be used successfully on human beings and might succeed in saving lives.

Up to this time that is to say from 1908 to 1924, all attempts had been in vain. No patient had lived longer than 5½ days. When they did not die on the operating table, as was almost always the case, they died during the next few days as a result of subsequent loss of blood, infection of the pleura and the pericardium or as the result of a pneumothorax. Since the Kirschner case, I know of numerous other attempts to operate, for example by Sauerbruch, but all were unsuccessful. I, myself, performed the operation on bodies on the dissecting table, and later tried to save a

<sup>1</sup> Lecture presented before the Mayo Clinic, Rochester, Minnesota, New York Post Graduate Medical School and Mount Sinai Hospital, New York.



Fig. 9



Fig. 10



Fig. 11

Fig. 9. Extensive synovial hypertrophy joint injected with 100 cubic centimeters iodized oil. Shown, the enormous distention of the suprapatellar pouch divided into two separate compartments. (Case 5, M. S.)

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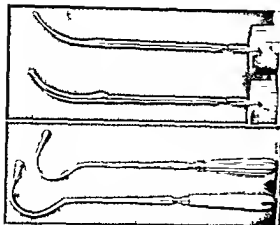
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Figs 1 and 2 Original Trendelenburg clip and sound and author's modifications of each. The upper figures in each picture are the author's modifications.

patient who was dying of embolism of the lungs. This first, unsuccessful operation showed me that (1) the opening of the pleura implies the infliction of a stupendous shock upon the already injured heart (2) the Trendelenburg sounds and clip must be improved as will be shown and (3) the strangulation period of 45 seconds caused by the introduction of the rubber tube around the great vessels puts too much strain upon the already laboring and dilated heart (a sound heart may be able to withstand this period) and that this period of strangulation evidently induces a paralysis of the respiratory centers which becomes irreparable.

I began dissection experiments in order to find out if the pulmonary artery could not be reached

through an extrapleural route. I soon discovered that this could be accomplished in spite of the fact that Trendelenburg stated that he had discovered from his exhaustive studies, that it was impossible to avoid the laying open of the pleura. Kirschner also said that in spite of the extreme danger of infection and the formation of empyema one must of necessity open up the left pleural cavity, however unpleasant the one-sided open pneumothorax might be in the case of a patient fighting hard for his life.

I constructed a pulmonary artery clip with weaker and narrower branches so as to restrict the side stream of blood as little as possible (Fig 1). I had the Trendelenburg sound made of a smaller size as the original model caused great inconvenience when it was inserted (Fig 2). I also covered the pulmonary artery clip with gauze instead of rubber. With these simple improvements I was able to save the next two victims of embolism upon whom I operated.

In the first patient (34 years of age) 6 days after a gynecological operation there were signs one morning of a severe embolism of the lungs—sudden decline, cyanosis, pallor, labored breathing, pulse barely discernible. The Trendelenburg operation was contemplated but was not considered to be necessary as yet. At 2 o'clock the physicians on duty were summoned with the cry 'The sick woman is dying! Her daughter who was with her rushed to meet us with the cry 'Help! help! my mother is dying! No pulse, heat could be felt and the patient breathed with the utmost difficulty. She was chalk white and no longer reacted. Operation was started within 2 or 3 minutes. A T-shaped incision was made from the second to the third rib, extensive resection of these ribs was done and the pericardium was cleared from the pleura and the mammary artery. The pleura was as thin as a spider's web so that the lung could be seen moving beneath it. A slit was made in the pericardium and the Trendelenburg sound was introduced. The pericardial fat was scraped from the pulmonary artery which lay still broad and with

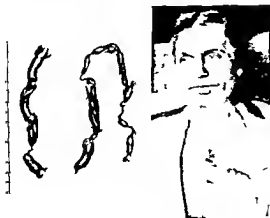


Fig 3 left Specimen removed from first patient.

Fig 4 Photograph of first patient showing scar from operation.



Fig 5 left Specimen removed from second case.

Fig 6 Photograph of second patient.

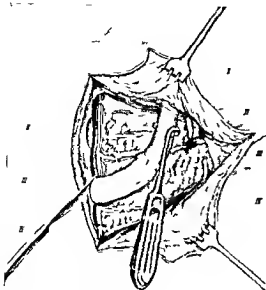


Fig 7 Excision of rib



Fig 8 The forefinger of the right hand gently pushes under the insertion of the fourth rib

out pulsation. The pulmonary artery was incised and the sound was thrust rapidly three times into the right branch. No more emboli could be found on the third insertion. The heart then beat much more feebly and the breathing became more labored. At this tragic moment the operator had a happy inspiration and squeezed the slit in the pulmonary artery between the thumb and forefinger. This made it possible for the blood to circulate more freely because the rubber tube could now be released. At once there was improvement in the heart beat and in respiration. A few seconds later as the heart action had greatly improved slight tension was placed on the tube and triple

investigation of the left branch again resulted in the removal of large emboli. The pulmonary artery clip was fixed on the side. The heart began to flutter and respiration ceased. Gentle massage of the heart with the fingers

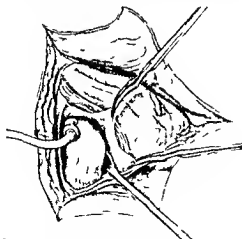


Fig 9 Modified Trendelenburg sound introduced and rubber tube being passed around pulmonary artery

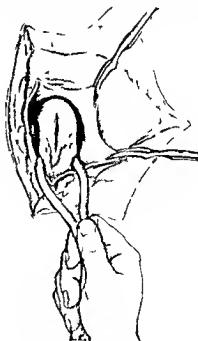


Fig 10 Trendelenburg rubber tube in place



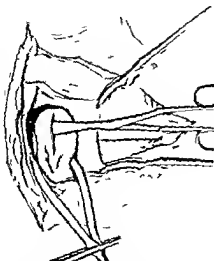


FIG. 11 Trendelenburg forceps are almost horizontal

induced a few faint beats but respiration remained totally inhibited. The sick woman lay like a corpse entirely without reaction. At the moment when the operator was about to order artificial respiration my first assistant Dr. Djalo zivska suggested giving carbon dioxide according to Henderson's method, and just as experiments had shown us the patient drew a deep breath. A heart beat followed then another and the heart once more beat regularly. We could now row up the vessel. The pulmonary artery clip was removed. Blood escaped at one point so the clip was put back and another suture was made. This overcame all bleeding. The pericardium muscle and skin were sutured. When we started to suture the skin the sick woman had revived sufficiently to cry out in pain and consciousness returned. Her color was perfectly satisfactory when she was taken back to bed. After a number of anxious days she made a complete recovery. Figure 3 is a picture of the specimen and Figure 4 of the patient.

The successful outcome in this case was followed a few weeks later by another successful result after a modified Trendelenburg operation.

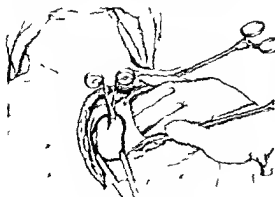


FIG. 13 Vertical exploration for embolus

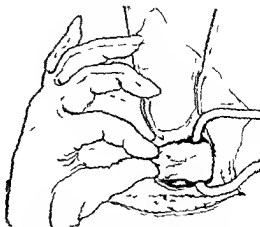


FIG. 12 Incision in artery grasped between thumb and forefinger to close it

One day when I was in the midst of an operation on a woman 60 years of age dying of an embolism was wheeled into the operating room. She had been operated upon 24 days previously for gangrenous appendicitis and embolism of the lungs had suddenly set in. In a few minutes I was able to do an embolectomy and even though it seemed that we might be too late we saved the patient (Figs 5 and 6). The woman lived nearly 4 weeks after the operation making the best possible progress. She was about to leave her bed. I was unfortunately absent when a new embolism caused her death. Postmortem dissection showed that the embolism had come from the other leg. The sutures on the pulmonary artery were perfectly healed. No thrombosis had arisen from them so that one might say that the method was successful in this case also.

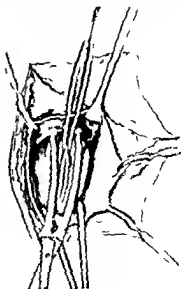


FIG. 14 Puncture covered with gauze on cranial end of incision

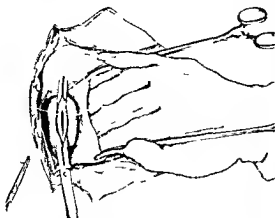


Fig. 15 Suture of incision commenced

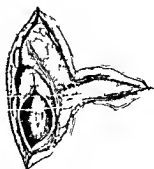


Fig. 16 Suture of pericardium

## TECHNIQUE

The steps of the procedure may be given as follows

Since one is operating upon the dying the operation is almost bloodless. The second and third rib must be laid bare with swift, large strokes of the scalpel. These ribs must be freed from periosteum and pleura quickly but very cautiously (Fig. 7). The operator now gently pushes away the mammary artery and the pleura. The forefinger of the right hand is inserted to enter by way of the lower medial angle partly under the breast bone and the operator's hand gently feels its way under the insertion of the fourth rib (Fig. 8). The pericardium shining white and partly covered with fat is plainly in view. Incision with the knife is followed by a flood of pericardial fluid. The pericardial cavity is laid open by introducing cautiously and energetically both forefingers which are spread out. Thus the pleura is pushed still farther out of place, and the pericardial cavity can be opened to a surprising extent.

The next step is the insertion of my modified Trendelenburg sound and the placing of the rubber tube around the artery (Fig. 9). On the cadaver one may be in doubt as to which is aorta and which is pulmonary artery. In the living or rather the dying body there can be no doubt—the aorta lies hidden and the pulmonary artery, swollen and pulseless is at once visible. The Trendelenburg rubber tube (Fig. 10) is useful as we shall presently see, not so much in strangling the vessels as in bringing the large vessels out of the depths which may be considerable in the case of fat patients so that they can be better observed. The pulmonary artery is incised, the tube being held lower. A quantity of blackish blood rushes

out. Emboli which may come from the heart, are also flooded out. Greater tension is now applied to the rubber tube. Forceps are placed in the right pulmonary branch, and the Trendelenburg embolus forceps is now almost horizontal. If the right branch is found to be free of emboli a triple investigation suffices, then the incision in the pulmonary artery is grasped with the thumb and forefinger of the left hand and is pressed together. The tube at once becomes absolutely relaxed. The blood is allowed to flow through the pulmonary artery for a few seconds when, for the first time the tube is fairly energetically tightened and an almost vertical, triple penetration is made into the left branch (Fig. 13). The heart is then relieved by means of renewed digital compression of the slit in the pulmonary artery with the tube quite relaxed. Now for the second time the tube is forcefully tightened. The left hand grasps the cranial end of the slit vessel with a pincers covered with gauze and holds it aloft (Fig. 14), the right hand attaches the arterial clip on the side, the tube is released. Any tightening of the tube naturally renders the work of the heart more laborious and thus injures it. The assistant must be cautioned regarding this, and must be ready instantly to obey the command 'relax,' 'more relaxed,' 'somewhat tighter,' as the case may be.

I have given you an exact description of the manipulation of the rubber tube, because I believe that the respiratory center is very sensitive and should be shut off as little as possible from the arterial blood supply. It has recently been contended that strangulations can be endured as long as 60 seconds. I consider all lengthy strangulations to be dangerous for the nerve centers and those operators who trustfully make use of them will



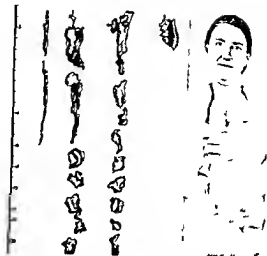
Fig. 17 Instrument case Instruments are arranged in the order of their use

certainly be disappointed. The digital compression of the slit in the artery and at the same time the keeping of the tube as slack as possible—it is really only necessary to tighten it forcefully as the artery clip is attached—are certainly the least dangerous methods of procedure. In my third successful case, strangulation was reduced to a minimum and respiration though feeble did not cease for a moment.

The following case shows how sensitive the respiratory center may be. A woman who had a fracture of the leg was brought into the operating room looking like a corpse, she did not breathe and the heart had ceased to beat. Since I am an optimist, I attempted to extract the embolus precisely according to my modification, whereupon the heart which as stated was quite still began to beat slowly to the astonishment of us all, and then to beat so quickly and violently that the artery clip on the side had to be held to prevent its being hurled away from the heart. We thought that we might save the woman but the respiratory centers reacted neither to carbon dioxide, Lobelin or any other measures and after artificial respiration had been practiced for an hour the heart flagged and collapsed and nothing could be done.

This experience shows how sensitive the respiratory center is and therefore how important it is to have the strangulation of the vessels as short as possible. When respiration has become regular and the heart beat stronger and more rapid then suture of the vessel can be undertaken deliberately (Fig. 15).

In such instance the heart pulsates sturdily, respiration is good, the face of the sick person which was previously of a deathly white becomes rosy, the muscle vessels begin to bleed, they are ligated, and the pericardium muscle and skin are sutured and so the seemingly magic transformation of a patient from death to life in the course of a few minutes is accomplished.



Figs. 18 and 19 Photographs of clots removed and of patient showing scar

The successful outcome in these 2 cases led us to give further attention to technique of this operation. We constructed an instrument case which contained all the necessary instruments for the operation (Fig. 17). When this case is unrolled everything is in readiness to proceed. The nurse in attendance hands out one instrument after another just as they lie in the case.

The next patient with embolism of the lungs came to us a year later. This case was especially interesting because it demonstrated the value of patience and perseverance. To sit many hours at a time by a patient's bedside is by no means pleasant but it is sometimes well repaid by the results. It shows us that when an embolus is once on the move one has a right to demand of an operating surgeon today that he should have a practiced hand and should be prepared to wait patiently and possibly to perform an operation after a delay of many hours. On four occasions we have waited hour by hour—once in the Charlottenburg Maternity Hospital. This patient developed a severe embolism about 8 days after childbirth. The obstetrician urgently desired an embolectomy, for according to their experience which was undoubtedly extensive they had never seen a patient recover after such a severe case of embolism in child bed. In my opinion however the patient was not a dying woman and this proved to be true for she made a good recovery without operation. If one does not keep watch by the bed of such a patient however it may happen that the fatal jerk upward may happen just when he is absent or that the over

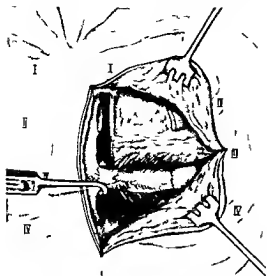


Fig. 20 The raspatory is introduced close to the sternum at the cartilaginous portion of the second and third ribs

burdened heart may suddenly collapse while the surgeon is away

The third case in which I did a modified embolus operation with success was that of a patient who was operated upon for a ruptured ovarian tumor. The wound healed splendidly. Ten days later at 6 o'clock in the morning, signs of a very severe embolism manifested themselves. The sick woman continued to recover under continual watching until at about 6 o'clock in the afternoon a renewed severe clotting ensued. Still I was not at all inclined to do an embolectomy. However I continued to keep watch by the sick woman's bed until 12:15 that night when the heart beats became fainter and fainter, the breathing more and more dyspnoic and consciousness evidently began to vanish. The patient's last words were "I think I'm going to die." Her pulse could scarcely be felt, respiration most arduous and superficial and she looked like a dying woman. We did the typical operation as already described. The wounds healed without any further incident (Figs. 18 and 19).

As I have already said, up to now only Kirschner has been successful with the original Trendelenburg method (resection of the second rib trans pleural procedure) and I believe that he was successful only because his patient was young and her sound young heart was able to withstand the enormous burden laid upon it by the pneumothorax.

It gives me great joy to say that two surgeons in Sweden, who had heard my lecture and had seen my demonstration at the Surgeons' Congress in 1926 and who had previously not been successful when they used the original Trendelenburg method have now had splendid results when they followed my method precisely. These two

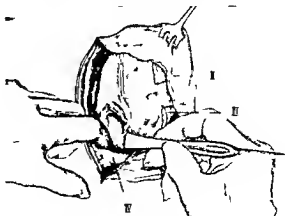


Fig. 21 Pushing away fat with handle of scalpel and pleura with forefinger of left hand

Swedish surgeons have each had two successful cases. These with my 3 cases make 7 cases reported in which operation has been successful.

Unfortunately, I experienced a great disappointment a few months ago. A very large man of 50 years of age contracted an embolism of the lungs after a simple appendectomy. The extrapleural clearing and the opening of the pericardium were accomplished according to our usual technique, but on account of the unusual depth in which the organs lay, as the patient was very fat, I had the misfortune to injure the heart in introducing the Trendelenburg sound. This had previously happened to others among whom might be mentioned Trendelenburg himself and Sauerbruch. This accident caused me to make many further experiments on the dissecting table, and I can now present the steps of an operation which is so abbreviated and simplified that it can be carried out without difficulty by any surgeon or gynecologist even by those who are not familiar with the technique of resection of the ribs. Previously, subperiosteal resection of the ribs with a pleura often as thin as a spider's web, was a task especially in a moribund patient, extremely trying. The operation must be carried out with meticulous care and yet with great rapidity. With my technique however, one can resect the ribs in a few seconds and the steps of the operation are simple and the pleura is not opened or injured. This technique has not previously been described. The sternum must be exposed more than usual. It is not resected extra pleurally as usual at the bony portion of the ribs. The raspatory however, is introduced quite close to the sternum at the cartilaginous portion of the second and third rib (Fig. 20). This takes only a few seconds. Fat lies

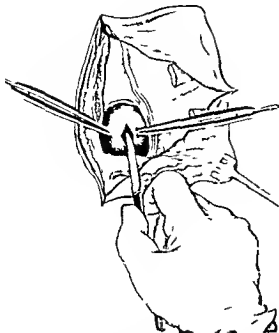


Fig. 22 Incision into pericardium

beneath, loose, and can readily be pushed aside. Here the Doyen raspatory is brought into play. It is inserted medial to the internal mammary artery and when pushed further in a lateral direction we resect the ribs extrapleurally as far as necessary and without danger to the pleura, because in this layer, the pleura is surprisingly easy to remove. Even in the case of the most aged subjects, the operation is done with undreamed of rapidity and certainty. With a large bone forceps three nips, about  $\frac{1}{2}$  a centimeter broad, are made in the sternum at the level of the second and third rib. The fat and pleura under the sternum have previously been set aside with the raspatory. The reversed handle of the scalpel is used to push away the fat of the epicardium and the pleura on the right side, and the left forefinger is used to push away the pleura on the left (Fig. 21). Immediately the pericardium comes into view it is brought up between two rigidly bent pincers and an incision is made and then widened digitally, as I have already described (Fig. 22). The two forefingers slowly but very forcefully widen the pericardial slit the left proceeding cranially as far as the first rib the right as far as the fourth rib (Fig. 23). The space now is very large. The right auricle is plainly visible and it is at once apparent how easily and quickly the small model of the Trendelenburg sound can be introduced (Fig. 24).



Fig. 23 The incision is slowly but forcefully widened with the two forefingers

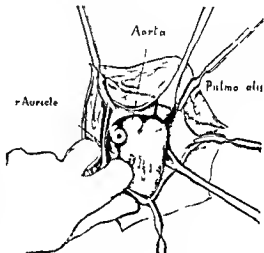


Fig. 24 Right auricle exposed

Injury is no longer possible. We have not as yet had a chance to operate on a dying patient with this method, but I am convinced that this further improvement means considerable simplification of the operation—something which doubtless will make the operation popular. From inquiries and replies from many surgeons it would seem that the bad results from operation are due to the fact, that even by extrapleural procedure overhasty operators tore the pleura. With my modification this can not happen.

I am convinced that since no means has yet been discovered of obviating postoperative thrombosis and embolism the Trendelenburg operation will be more and more used and that it will be practiced by other operators just as is any other operation. The operation is not so difficult as it would perhaps appear. I therefore hope that my suggestions will induce others to try my technique and that they will be successful in relieving patients suffering with this fatal malady.

## PROLAPSE OF THE INTESTINE THROUGH A PREFORMED OPENING IN THE GREAT OMENTUM

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THE finding at operation of one or more apertures in an otherwise unremarkable omentum majus is not a rarity. Such unsuspected slits are generally found at the termination of an abdominal operation. They may, of course, be due to injury incidental to the operation at hand, but again, in some instances, they are noted before operative interference and when found, are repaired, and prove of no further significance.

That a slit or slits of this sort may form the starting point for some intra abdominal catastrophic, such as the ensnaring of a segment of intestine appears reasonable. The occurrence of such an event, however, from a review of the literature, appears extremely rare, and it is difficult to say anything concerning its actual incidence. Makins, in a study of 400 cases of intestinal obstruction, reported one instance (0.25 per cent) wherein an opening in the omentum was the cause of an obstruction. No description is given of this case.

We are concerned, in this discussion only with openings in the omentum that are apparently preformed and not obviously the result of inflammatory adhesions. This therefore, excludes those instances in which adhesions between the margin or other portions of the omentum to each other as well as to contiguous structures result in constricting bands or what at times appear to be abnormal apertures.

Concerning the etiology of omental openings there is probably more speculation than actual information. From the appearance of one of these slits it is probably impossible to determine whether the abnormal opening is of recent or remote formation. It would appear rather arbitrary to consider such openings congenital unless they are formed in the early period of life, in fact, Prutz believes that the most common cause of omental openings is the gradual atrophy of the connective tissue.

From a review of the available literature the following personal observation forms we believe the sixteenth case record of its kind.

E. A. L., a white woman aged 24 years was first seen October 29, 1927. The family history was altogether irrelevant. The past history was entirely negative except for the following notations: For several years the patient had had more or less abdominal gas with a sense of epigastric fullness immediately after meals. Belching gave relief and

there was no history of pain or constipation. One year ago she had bladder trouble which lasted 3 days. This was not treated by a physician and was not associated with abdominal symptoms.

The menstrual history was irrelevant. The patient had been married 8 months.

The present illness began 9 days previously at which time the patient began to have chilly sensations. Two days later she experienced acute epigastric discomfort with nausea and vomiting. This discomfort became generalized to the entire abdomen but was most noticeable in the right iliac quadrant. The discomfort was constant dull and aching with exacerbations which were not colicky like and did not radiate. There was no further nausea or vomiting but the chills persisted as did the abdominal discomfort and for 2 or 3 days there was urinary frequency and burning.

**Physical examination.** The temperature was 99 degrees F. pulse 64 respiration 14. The entire examination was irrelevant except for the abdominal findings. The abdomen was symmetrical and moved freely with respiration. At first there was such marked cutaneous hyperesthesia in the right iliac quadrant that it was almost impossible to touch the patient who was very apprehensive. However when the examination was finally satisfactorily performed there was elicited generalized abdominal discomfort on palpation and percussion but no rigidity or muscle spasm. There was also some discomfort to pressure in either costovertebral angle. No viscera were felt; the flanks were tympanitic and the area of hepatic flatness was normal. The pelvic examination was irrelevant.

A provisional diagnosis of pyelitis was made with appendixitis as a possibility.

In the hospital the patient's temperature was never above 98.6 degrees F. The white blood count on two occasions totaled 9,800 and 7,000 with 70 per cent and 60 per cent polymorphonuclear neutrophilic leucocytes respectively. The blood Wassermann reaction was negative. A urine specimen obtained by urethral catheterization contained numerous leucocytes and gram positive cocci. A cystoscopic examination with bilateral ureteral catheterization was irrelevant except for a very moderate hyperemia of the bladder mucosa while microscopic preparations and cultures of the urine from either kidney showed just a few leucocytes and gram positive cocci in stained smears of the dried sediment. The cultures showed a staphylococcus.

The abdominal symptoms persisted and in spite of the evidence of a pyelitis it was obvious that the pyelitis was not producing either fever or leucocytosis and therefore was not the cause of the abdominal symptoms.

Operation was performed November 3, 1927. An appendix normal both macroscopically and histologically was removed. A complete exploration was also irrelevant until at its termination the reflected omentum was turned down for interposition between the parietal and visceral peritoneum. It was then seen that a loop of intestine lay upon the anterior aspect of the omentum. Closer inspection revealed two openings in the omentum in about the midline the smaller one superior to the larger as shown in Figure 1.

The smaller opening was oval measured probably 1.5 to 2 centimeters in its greatest dimension and was situated about 2 to 3 centimeters inferior to the transverse colon.

### CASES FROM THE LITERATURE

Authors Name	Date	Age of patient	Sex	Portion of intestine involved	Symptoms	Outcome	Remarks
No author's name	1840	49	F	Small	Typical of obstruction	Death on second day No autopsy	Patient had cancer of uterus. Autopsy some small intestine had peritritid swelling though the omentum did become slightly congested - almost gangrenous
Curran J W	1860	22	F	Small	Typical of obstruction	Death on 16th day No operation	Child previously well. Frightened by diarrhoea and while running felt a little pain in belly. Good sized stool in morning in bed. Umbilicus with good sized knot. No gangrenous protrusion through. Peritonitis
Piera A	1872		M	?	Typical of obstruction	Operation Recovery	Loop of intestine had passed through at anterior abdominal wall in extent of about 1/2 inch. Intestine recent origin. Slight redness to the first border. 1/2 inch great omentum. No gangrenous. Nothing in description to show its traumatic origin
Coley and Lawson	1872	47	M	Small (2 cm) 40 inches long	Typical of intestinal obstruction	Operation Death Cause of obstruction not found at operation	Autopsy 40 inches of small intestine black black had passed through abdominal wall. 2 inches in circumference in right lower abdominal omentum free. No adhesions
Lidd S	1882			Small			Author mentions a case of von K. which is a testicular obstruction due to loop of intestine passing through opening at margin of peritonium
Blakely A	1886	27	M	Apparently small gut Length not given	Typical of intestinal obstruction. Fecal contents No abdominal sign	Operation Recovery	Patient had had previous similar attack. One terminal ileum resected. Intestine incised and easily released. No previous operation
Cattell H W	1896	36	M	Small to 11 feet	Typical of obstruction	Death. Findings at autopsy	Intestine to necrosis. Bloody fluid in peritoneal cavity. Omentum opening localized in description
Gunnard A	1898	24	M	Small	Typical of obstruction	Operation Recovery	Tuberculous peritonitis. Omentum appeared as a white mass in hernia in three places of which was uncalculated. No previous operation
Gorik A	1898	82	F	Transverse and descending colon	Typical of intestinal obstruction	Operation Recovery	Operation 4 cm. retro meter at edge of loop in edge of mesenteric ligament in thick wall and almost cartilaginous consistency. Cecum. Hernia out of peritonitis. The distal part of small intestine origin other than a simple tear in the mesentery
Barling A S	1898		M	Small	Strangulated in hernia	Operation Recovery	Omentum and intestine in hernia sac. Strangulation due to ileus a passive. Necessary to turn to relieve intestine
Lusana A	1899		M	Small	Typical of obstruction. Tumor 1 ft to left of umbilicus. Distal intussusception	Operation Recovery	Patient had typical symptoms. By loop of small bowel intussuscepted by operation. A great intestinal mass. Bowel gangrenous. Adhesions mesenteric distal part of small intestine use of small and mesenteric areas of ulceration with grayish yellow bases. Bowel distended
Goodman Chas	1900	67	M	Small 5 inches long	Typical of obstruction	Operation Recovery	Intestine strangulated due to volvulus. In ascending terminal opening 2 inches from ileocecal junction. Reopened by cutting on lumbar peritoneum
Layke Wm	1907			Small			A short report of cases of intestinal obstruction. One of these a case of intestine passing through a opening in the great mesentery which was evidently recent. Intestine. In the description of operation
Ditt J K	1913	43	M	Small 6 feet long	Acute upper abdominal pain 5 months past. Right distended with tenderness and general rigidity. Fever. Diarrhoea. Perforated gastric ulcer	Operation Recovery	Large amount of blood stain of fluid peritonitis. Intestine prolapsed in the abdominal cavity. Great mesentery at the ileocecal junction. Slightly dilated, dark purplish and gangrenous. Adhesions
Makins C H	1910						No description. Merely a reference to instance of testicular obstruction due to an opening in the mesentery
Martin J H	1920	24	F	Ileum	Intestinal obstruction. No previous diagnosis	Explosive peritonitis. Recovery	See text

The large defect also oval measured probably 5 to 6 centimeters and was situated about 2 centimeters inferior to the smaller one. A loop of small intestine (ileum I believe) protruded through the larger defect and lay upon the omentum to the right of the midline. The loop measured about 15 to 20 centimeters in its total length, was slightly distended and of a purplish pink hue. Its mesenteric vessels were questionably dilated though the subserosal capillaries were visibly enlarged. Reduction was easily accomplished and the intestine showed plainly the two points where the omental constriction had been effected.

The margin of the two omental apertures showed no evidence of hemorrhage or fibrin deposition. They were smooth and covered with a pale gray glistening and translucent serosa—evidently preformed defects of undetermined age.

The defects were repaired. The patient had an uneventful recovery and is well at the present time. There have been however occasional recurrences of the bladder symptoms.

This case differs from the others encountered in a review of the literature in that here the outstanding symptoms of intestinal obstruction were absent. It also illustrates the ease with which a symptom producing anatomical abnormality may be overlooked in an otherwise 'obscure case' unless the exploration is performed systematically and where possible under direct vision.

In the accompanying table are arranged in chronological order the reported cases of intestinal prolapse through a preformed omental opening. From this table have been omitted as previously noted, instances in which omental adhesions were the source of intestinal ensnarement. Particular mention may be made of the case reported by Brown which Prutz apparently accepts as coming within the group of cases we are considering. From Brown's description the omental slit was evidently due to an adhesion on the posterior aspect of the omentum. The intestine in his case had passed through an aperture that was posterior to the omentum. In other words there was no trans-omental defect and we have therefore not included this case in our tabulation. The cases of Atkins, Fowler and McWhorter also do not come within the scope of this paper. There may be some doubt as to the propriety of including the case reported by Gorski. This was one of an opening 4 centimeters in diameter at the edge of the omentum through which almost the entire transverse and descending colon had passed. The edge of the ring was about 2 centimeters in diameter and Gorski expressed the belief that the defect was inflammatory in nature rather than a simple tear in the great omentum. This is a most unusual case and probably belongs to the group we are studying.

It also appears that in his monograph Prutz accepts the case reported by Moller. In this in-



Fig. 1. Drawing showing location of openings in the omentum.

stance the omental opening was caused by the fusion of two pieces of omentum. The findings were made at autopsy which occurred 23 days after a previous abdominal operation and we are excluding this case from our tabulation.

From a comparison of the case reported by Cayley and Lawson from the Middlesex Hospital in 1877 with that of Coupland in 1879 we believe the two reports concern the same patient. In each description the omental defect is localized in the same situation in identical words, the amount of small intestine that passed through the omental aperture was 40 inches in each description and in both observations the site of the distal strangulation was 4 inches from the ileo caecal valve. We therefore have considered this a duplicated case report and have given priority to Cayley and Lawson.

A case reported by Kirchner also deserves mention. Here the jejunum had passed through the omentum but in his careful description Kirchner explains that the constricting bands were pro-



duced by adhesions of the margin of the omentum to the pelvic organs. This case has, therefore been excluded from our tabulation.

The tabulation is self explanatory. The number of reported cases is so small that one doubts the permissibility of any conclusions utilizing percentage figures. The following summary may serve to crystallize the few generalizations that may be drawn from this study.

#### SUMMARY AND CONCLUSION

1 Prolapse of the intestine through a preformed omental defect not due to adhesions is an exceedingly rare occurrence. In so far as we have been able to determine from the literature this case report represents the sixteenth instance.

2 It may occur at almost any age and there is not sufficient information available to indicate its predilection for any particular age period.

3 No definite predisposing factor has been determined.

4 The small intestine is the portion generally involved.

5 The symptoms of this condition are as one would naturally anticipate, typical of intestinal obstruction. In the case here reported the foregoing generalization is not applicable.

6 The outcome following timely operative intervention has been uniformly good.

#### BIBLIOGRAPHY

1. ATKINS R. A case of intestinal obstruction terminating fatally produced by the strangulation of the gut within a loop of omentum. *Dublin M J* 1878 u 431.
2. BARLING A. STANLEY. On the contents of hernial sacs. *Med Press & Circ Lond* 1898 cxvii 293.
3. BERLÉME NIX. Tre laparotomier for Ileus. *Ho pitalstidende* 1886 iv (Nr 33) 817.
4. BROWN W L. Case of strangulated hernia through an omental slit. *Med Standard Chicago* 1899 xxxi 530.
5. CASTELL H W. Internal strangulated hernia of the small intestine through the omentum. *Tr Path. Soc. Phila* 1896 xvii 71.

6. CAYLEY and LAWSON. Intestinal obstruction—enterotomy—death. *Med. Times & Gaz* 1877 u 462.
7. COOTLAND S. Hernia of ileum through a rent in the great omentum. *Tr Path Soc Lond* 1879-1880 xxxi 146.
8. CURRAN J W. Intestinal obstruction produced by a rent in the great omentum through which a portion of the bowel slipped caused by the fright of a dog. *Med Press & Circ* 1869 viii No 13 261.
9. DATTA J K. Acute intestinal obstruction due to strangulation through the great omentum. *Brit. M J* 1918 u 60.
10. FOWLER J K. Intestinal obstruction caused by constricting cords of omentum. *Tr Path Soc Lond* 1882 xxxiii 146.
11. GOODMAN CHARLES. Strangulation of small intestine through a slit in the omentum. *Med Rec N Y* 1906 lxx 713.
12. GORSEK K. Sellenner Fall einer inneren Darminklemmung. *Deutsche med Wchschr* 1895 xxi 233.
13. GUYARD A. Occlusion intestinale au cours d'une tuberculose péritonéale. *Laparotomie guérison opératoire et amputation notable de l'état général.* *Bull et mem Soc de chir de Par* 1893 p 693.
14. KIRCHNER WALTER C G. Observations based on seventy cases of bowel obstruction with special reference to the unusual cases. *Am J Obst* 1913 lxxvii, 942-953.
15. LISANTI A. Ulcerazione fistolosa del grande epiploon seguita da perforazione ed invaginamento dell'intestino tenue. *Riforma med* 1899 u 303.
16. MALINS G H. *Oxford Surgery*. Vol u p 810. New York: Oxford University Press 1919.
17. McWHORTER G L. Ends of omentum fused through opening in mesentery producing acute intestinal obstruction. *Surg Clin N America*. Philadelphia: W B Saunders Company 1928.
18. MOLLER F. Laparotomi rekonvalescens förmynad. *Ileus* dod. *Eira* 1897 xxi 321-330.
19. Strangulation of the small intestine by the omentum. *Medical Times Lond* 1840 u 197.
20. PIERI A. Di Uno Stragolamento Intestinale Interno. *Gastrotomia—Guarigione Sperimentale.* *Giorn Cnt damed e chir* 1872 xxx 30-39.
21. PFITZ W. *Deutsche Chirurgie* by Billroth and Luecke. No 45 K p 113. Stuttgart: F Enke 1913.
22. TAYLOR W. Intestinal obstruction. *Brit. M J* 1907 October p 893.
23. UNDE. *Chirurgische Behandlung innerer Einklemmungen.* *Handbuch der allgemeinen und speziellen Chirurgie*. Vol. iii 2d ed p 15. Stuttgart: F Enke 1832.

## MEDIAN COLOSTOMY

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SINCE colostomy was first employed for the purpose of providing an artificial anus, the left inguinal region has been almost invariably selected for its location. The sigmoid colon has been employed for this purpose more often than any other portion of the large bowel.

An abdominal opening over the point where the largest portion of this bowel is most often found, was the most natural one to be made. Inasmuch as an artificial anus functions best when the feces which pass through it are normal in consistency, shape, and quantity, as a general rule, the lower in the colon it can be located, the better it is.

The rectus muscle being thick and strong not only has made a good support for the bowel, but has exercised, at least to a slight degree, some sphincteric function.

It is gratifying to find so many patients who have been subjected to a colostomy in possession of so marked a degree of fecal continence as to be able to attend to their regular duties. In a large number of cases, however, the fecal discharge from a left inguinal colostomy has irritated the surrounding skin so that much discomfort has been suffered by the patient.

In people of slight build or those who have been emaciated as a result of their disease, the anterior superior spine of the ilium, being quite prominent, becomes eroded, ulcerated, and is made very sensitive. On account of this discomfort, dressings, bands, belts, trusses or colostomy apparatus could not be worn without increasing the patient's distress. This in many instances has created a problem the solution of which has been attended with considerable difficulty.

Patients forced to go through life with a colostomy and who must wear some sort of a bag or other retaining device are usually quite sensitive about their condition. Usually bulging or protrusion on the left side caused by colostomy pads, cups, or bags, causes such a distortion of the patient's contour as to be decidedly noticeable and embarrassing. This is particularly so in people who have become emaciated through illness. In women especially, the difficulty in arranging the clothing so as to disguise their infirmity has presented serious difficulties.

In performing a left inguinal colostomy, the surgeon is limited in most cases to the employment of the sigmoid colon for the colostomy.

The gastrocolic omentum does not allow of sufficient laxity of the transverse colon without undue strain on the stomach, to be brought down and successfully used in this region.

Before performing a colostomy obviously a complete exploration of the abdominal cavity is necessary for both positive and negative diagnostic reasons. An incision either at or near the median line must be employed to make a thorough, complete, and successful intra abdominal surgical examination.

If one elects to perform a left inguinal colostomy after such an examination, a second incision and opening into the cavity must perforce be performed. If, as is often the case, a colostomy is performed preliminary to a subsequent abdominal or abdominoperineal extirpation of a malignant growth of the rectum or sigmoid colon, it is quite important that the colostomy be placed not only as high up in the bowel as possible, but also that it be located as high up on the abdominal surface as possible.

By employing the descending or the transverse colon in some cases one is able to resect a larger portion of the colon above the growth and thus secure a greater margin of safety. By placing the colostomy well above the site of the wound which would be necessary for a subsequent resection a clean area is provided for the abdominal operation.

For some years we have been locating our colostomies in the median line, just above the umbilicus, and our patients have been able to wear colostomy bags with much greater ease than when the colostomy was located in the inguinal region.

One unsatisfactory feature in this location has been the soiling of the umbilicus by fecal discharge and the difficulty in cleansing this area. For this reason during the past 3 years we have been excising the umbilicus and using this site for the location of the colostomies.

The technique as first advocated by Angelo Sorel has been employed with slight modification in certain cases. By employing a natural opening into the abdominal cavity which the umbilicus provides we take advantage of the semicircular arrangement of the rectus fibers at this point as well as of the increased strength of the fascial tissue which lessens the tendency to possible later herniation.



Fig 1 left Line of incision  
Fig 2 Freeing the umbilicus

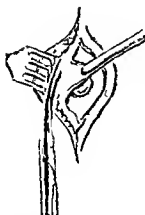


Fig 3 left Area punctured for insertion of rubber tubing  
Fig 4 Sectional view



The technique of operation as personally employed is as follows:

If local anesthesia is used a one half per cent solution of novocain in Ringer's solution is chosen. A subcutaneous injection is made from two punctures located at both poles of the proposed incision. This is very rarely longer than 3 inches and is made in the median line curving outward on both sides around the umbilicus above and below, and then again joining above. The fascia is punctured and the muscle infiltrated (Fig 1) on either side down to the peritoneum. Care must be taken not to puncture the peritoneum for fear of injuring the bowel. The umbilicus is grasped with an Allis forceps and freed right down to the peritoneum with scissors and by blunt dissection. Through a peritoneal incision just below the umbilicus an examination (Fig 2) is made in order to be sure that omental adhesions or protruding intestines are not present. With the removal of the umbilicus a sufficient opening into the peritoneal cavity is thus presented so that a complete ocular examination can be made.

By extending the incision downward and continuing the injection of the anesthetic solution and using great gentleness we can locate the neoplasm. Mesenteric traction must be avoided to prevent unnecessary pain. The liver, gall bladder and spleen can be palpated through a similar extension of the upper half of the incision. With rubber tipped forceps a portion of the descending or transverse colon is brought out of the wound. A non vascular area of mesentery (Fig 3) is punctured with hemostatic forceps

and a piece of  $\frac{3}{8}$  inch thick walled rubber tubing brought through this mesenteric opening to act as a support for the colon for the first few days. If the transverse colon is used sufficient omentum is tied off in sections so as to give a clean loop of bowel for the colostomy (Fig 4). The fascia and peritoneum are trimmed back on either side so as to allow the rectus muscle fibers to bulge into the wound. The peritoneum is closed above and below the bowel by plain catgut sutures and the muscle and fascia approximated by number two interrupted chromic catgut sutures. No attempt is made for the purpose of bringing the peritoneum up to the skin as recommended by some authors.

Much better muscular control is obtained by the adhesion of muscular fibers directly to the intestine. The skin is closed by clips and stearate of zinc powder or sterile vaseline applied freely over the protruding bowel.

Much more satisfactory anesthesia for this operation is that obtained by the subdural injection of novocain. Spinal anesthesia produces such a wonderful degree of intestinal quiescence that having once employed it in any type of abdominal surgery the surgeon is prone to use it always. The utter flaccidity of the abdominal wall as well as its contents renders intra abdominal examination of all of the viscera a matter of great ease. Any operation and especially on the colon is facilitated by a complete absence of intestinal movements which is so characteristic in etherized patients. The intestines are contracted and lie on the posterior wall of the abdominal cavity as they do in the cadaver.

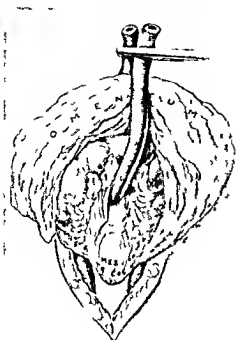


Fig. 5

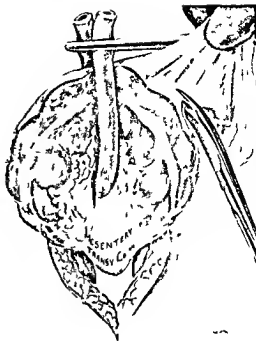


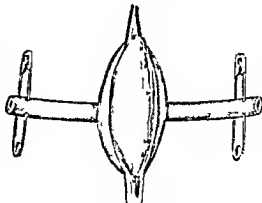
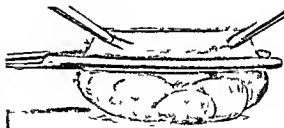
Fig. 6

The operative technique under spinal anesthesia is the same as when local anesthesia is performed. There being no protrusion of the intestines it is not necessary to use gauze or other substances as packs or coffer-dams; therefore no unwelcome intestinal adhesions are produced.

For several years, a very simple and satisfactory method of opening the colostomy loop has been personally employed. Noting the repugnance of the patients to the odor of their own burning flesh, the cautery has never been employed for the purpose of opening the colostomy. Incision is attended by unnecessary hemorrhage and is also disturbing psychologically, even though it is painlessly performed.

Usually, the opening of a colostomy means a second trip of the patient to the surgery or operating room, which is also often unnecessarily disturbing. For this and other reasons, opening the colostomy by means of pressure necrosis has been personally employed with very satisfactory results (Fig. 7).

After the operation described has been completed and before the dressing is applied, the exposed loop of colon is seized with two pairs of hemostatic forceps grasping the longitudinal muscular band about 3 inches apart. Traction is used to raise this portion up while a long curved



Figs. 7 and 8. Colostomy is opened by means of pressure necrosis. This method gives very satisfactory results.



Fig. 9 Colostomy completed

hysterectomy clamp is placed along the bowel just below the ends of the traction forceps. The clamping of this forceps puts pressure on a spindle shaped area which becomes the opening of the colostomy when the clamp is removed after 48 hours.

In this way a painless bloodless colostomy opening is produced without the patient being aware of it. The opening is satisfactory and is produced while the patient is in his own bed and it does not require any special preparation, instruments, or 'fuss and feathers'.

The skin surface surrounding the colostomy is kept protected with a large quantity of stearate of zinc powder not only during the healing process but afterward. The patient is encouraged to sit up in bed just as soon as the abdominal incision is sufficiently healed to allow the removal of clips or stitches. He is then urged to attempt to have a movement from the colostomy at regular stated periods usually morning and evening.

If no movement is secured, the colon is flushed through the colostomy, with a few ounces of saline or soda bicarbonate solution. By hold-

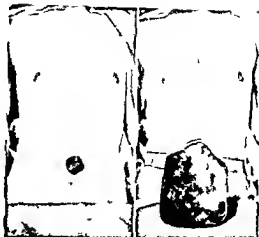


Fig. 10 Photograph of patient showing colostomy and belt with removal bag

ing a crescent basin under the colostomy with one hand while with the other, he irrigates with a bulb syringe the patient is able to take care of himself nicely without assistance.

A colostomy belt with a removable bag is used, which is very light in weight and which is inexpensive. This has been found much more satisfactory than the more expensive and complicated types of apparatus. The patient is encouraged to walk as soon as he is able and to get out of doors and resume his normal routine of life.

I fully believe that a median colostomy is more strongly supported by surrounding tissues, than is one located in the inguinal region. On account of this fact, the convalescence is more rapid and the patient is able to resume his activities in a much shorter period of time which is a good thing from a psychological standpoint as well as a physiological point of view.

## IMPLANTATION MALIGNANCY OF THE ABDOMINAL WALL

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THE fear of local recurrence of malignant tumors prompts the surgeon to excise the initial lesion as widely as he dares. Invasion of the abdominal wall by extension from intra-abdominal malignancy is not so unusual and is an occasional sequel to advanced tumors of the large bowel. Implantation of neoplastic tissue into the abdominal wall during excision of an intra-abdominal neoplasm without its recurrence within the abdomen is, however, a very unusual occurrence. A careful review of the literature has borne out this impression. The rarity of this occurrence justifies the report of the following case.

Mrs. M. W., 69 years of age, white female housewife was admitted to the University Hospital in May 1923 complaining of a tumor of the anterior abdominal wall. The patient was a healthy individual throughout her youth, suffering only a few of the common illnesses of childhood. Her menses appeared at the age of 13 years and were regular and normal in every respect. She was married at 21. She was never pregnant. Her menses continued normal until she reached her middle thirties when they appeared every 2 to 3 weeks. Pain and profuse vaginal bleeding was noticed then on the first day of each menstrual period. This caused her to seek medical advice and treatment.

In 1907 at the age of 48 years she had erysipelas of the face for several weeks. In the winter of 1907-1908 she visited her physician because of menorrhagia and was told that this was due to change of life. In April 1908 a curettage was performed and a small fibromyoma of the uterus was removed. Following this she developed increase in leukorrhea. In June 1908 the appendix, right ovary and right tube were removed. In November 1908 the uterus, left ovary and left tube along with a cyst and two tumors of the uterus were removed. These latter were found to be large fibroids. The abdominal wound became infected and healing was somewhat slow. Dr. Ray Knight, who assisted at these operations and who saw the patient from time to time, has kindly given us the information relative to her operations. Dr. F. R. Woodward, who performed the original operations at the old Ashbury Hospital, Minneapolis, is deceased and the hospital records of that time are not available.

The patient continued apparently healthy until 1921 when she first noticed a lump about the size of a walnut in her left lower abdominal quadrant. At first it grew slowly and then more rapidly until May 1923 by which time it had developed to the size of a small football. Shortly thereafter she was admitted to the University Hospital. At this time she was suffering from sharp burning pains at the site of the tumor mass occurring four to five times a day but not radiating in any direction. Her best weight had been 180 pounds but she had lost 17 pounds during the 6 months previous to her admission here. She also complained of some weakness. The family history revealed that only one relative, a great aunt, had died of some form of cancer.

The physical examination showed on palpation and inspection a hard diffuse mass about the size and shape of a small football extending in a slightly oblique direction from a point 5 centimeters below and 9 centimeters to the left of the umbilicus to a point on the pubic crest 3 centimeters to the right of the midline. This mass was slightly tender on pressure and appeared embedded in the musculature of the abdominal wall because it could be moved about freely with the abdominal wall and also because the skin could be easily lifted away from the mass. Three centimeters to the right of the midline and extending upward from the pubis to a point half way between the latter and the umbilicus was a scar from the operations of 1908. Beneath this scar the abdominal wall appeared rather thin and to its right edge of the tumor was fixed. It was felt that this tumor was probably a desmoid of the rectus sheath and excision was recommended. No adenopathy could be demonstrated.

The tumor, including a large part of the left rectus muscle and its anterior sheath, was removed on July 27, 1923, by Dr. A. L. Cameron. On microscopic examination the tumor was found to be an adenocarcinoma, its structure closely resembling alveolar glands lined by columnar epithelial cells. Convalescence was satisfactory and she was discharged apparently well. During 1924 she received superficial X-ray treatments for her abdominal wall condition as prophylaxis against recurrence.

However, the patient was readmitted to the University Hospital on June 26, 1925, because of recurrence of the tumor and abdominal pain. There was found over the site of the previous operation a large postoperative incisional hernia. In the abdominal wall about a centimeter to the left and slightly below the umbilicus a round hard tender mass about the size of the patient's fist was palpable. Over the pubic region was found a hard nodular irregular mass roughly 8 by 5 by 5 centimeters in size, adherent to the pubis and tender on palpation, first noticed in September 1924. The adnexa were negative. The pelvic floor was normal. The rectal examination was negative. The patient complained of numbness and pain in the left lower extremity which radiated from the sole of the foot to the thigh. She had lost 20 pounds in weight since the fall of 1924 and had become progressively weaker. On July 12, 1925, 900 milligram hours of radium in needles were inserted into the suprapubic mass.

On October 29, 1925, the patient was readmitted for the fourth time. The suprapubic mass was smaller, she felt better and she said that she did her own housework. The mass near the umbilicus, however, was somewhat larger. The following day she was given 35 milligrams of radium for 10 hours into the suprapubic mass, a total of 350 milligram hours and advised to return later for superficial X-ray treatments of the umbilical mass. She was very co-operative and appeared regularly at the out-patient clinic at intervals of about 4 weeks. Each time she received approximately 40 per cent of a skin erythema dose to the mass near the umbilicus. Treatment was continued until the summer of 1926 when she said she felt good. The abdominal wall tumor had become smaller. The new Cancer Institute at the University of Minnesota, having now been fully established as a unit of the University Hospitals, deep X-ray therapy was begun. Between August,

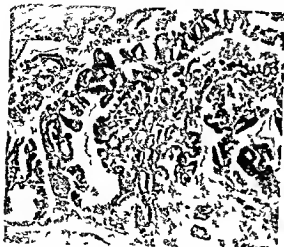


Fig. 1. Photomicrograph of ovarian cystadenocarcinoma removed at time of necropsy from the abdominal wall of our patient.



Fig. 2. Same as Figure 1 under higher magnification.

1926 and March 1927 she received three series of deep X-ray therapy.

On June 7 1927 she was readmitted for the fifth time. There were many small nodules which could be felt on palpation slipping around beneath the skin of the lower abdomen. She felt quite well except for a dull pain in the back which was now more or less constant. Her appetite was good she had no pain in the abdominal masses and felt fairly strong. On June 13 1927 X-ray examination revealed metastases involving the fourth and fifth lumbar vertebrae which accounted for the pain in the back.

Further deep X-ray therapy was recommended. This was instituted and by August 1927 the abdominal wall tumor near the umbilicus could scarcely be palpated and she again felt much better. Altogether she received between June 23 1927 and December 1927 three series of deep X-ray treatments receiving each time a 110 per cent skin erythema dose to the central part of the pelvis and spine. In January 1928 the scar tissue surmounting the postoperative incisional hernia and tumor area began to break down. By April 1928 following nearly a week of obstinate constipation an intestinal fistula developed opening onto the abdominal surface.

The patient was admitted to the Minneapolis General Hospital in August 1928 with a history of mental confusion for 2 days and constipation for 4 days preceding admission. She complained of shooting pains about the pelvis radiating to the umbilicus. The clinical impression was generalized carcinomatosis. A history note of October 1928 mentioned the persistence of a large hard abdominal mass on the left side. There was considerable emaciation at that time. Death occurred on November 26 1928.

The postmortem examination revealed a pear-shaped abdominal defect 10 centimeters by 5 centimeters immediately above the symphysis pubis. In the abdominal defect were two fistulous openings one connecting with the ileum at a point 50 centimeters from the ileocecal junction the other with the midportion of the transverse colon. The intestines in the upper part of the abdomen were bound down by adhesions. The peritoneal surfaces were free of metastases. The pleural and pericardial cavities were free of metastases. No lymph node involvement could be demonstrated. However metastases were found in the

fourth and fifth lumbar vertebrae. The bones of the pelvis appeared normal. The organs of the head and neck were not examined.

Below and to the left of the umbilicus was a fleshy tumorous mass 5 centimeters by 2 centimeters in the left rectus muscle region. Microscopically the tumor was found to be composed of many atypically and poorly formed alveolar structures lined by tall columnar cells and supported by a thin stroma. In many of these alveoli the lining cells had proliferated to the extent of forming fine dendritic processes projecting into the lumen occasionally forming the point of separation of one partly formed alveolus from another. The picture as a whole was that of a papillary cystadenocarcinoma very likely of ovarian origin. The following anatomical diagnoses were made: (1) emaciation and cachexia (2) hypostatic bronchopneumonia (3) implantation carcinoma in the abdominal wall with metastases to the spine (4) intestinal fistula.

It is believed that the origin of the neoplasm in the scar of this case can be attributed to implantation of a portion of the supposedly benign ovarian cyst into the abdominal wall incision at the time of operation in 1908.

In contrast to implantation in the abdominal wall extraperitoneally a much commoner condition is the well known intraperitoneal dissemination from a benign ovarian cyst with implantation upon the peritoneal surface. This process was probably first recorded in Baker Brown's celebrated case which was described by Beigel in 1869.

Wagner (1864) probably described the first case of benign ovarian tumor reproducing its structure

in the abdominal wall proper. A former prostitute, who over a period of 13 years was tapped 42 times because of ascites, had developed three subcutaneous cystic tumors below and to the left of the left breast, in the right axillary fossa, and in the left flank region. These tumors were secondary to the very large intra abdominal benign papillary serous cyst arising from the left ovary. The histological structure of all was identical, as proved at necropsy.

Baumgarten (1884) mentioned the extirpation of a benign papillary serous ovarian cyst. At necropsy sometime later, secondary tumors all histologically benign and identical with the primary ovarian cyst, were found to have occurred not only on the inside of the peritoneum, but also in the abdominal wall extraperitoneally.

Olshausen (1899) described the instance of a woman aged 46 years who had had a left oophorectomy performed in 1878. In 1895 she was operated on by him for an abdominal wall tumor of the right side just above the navel. Histologically, the latter was a benign papillary ovarian cystadenoma. The author believed this to have arisen undoubtedly by inoculation of the abdominal wall during the operation done 17 years previously.

In the same paper this author mentioned another case of a woman of 53 years, who in 1889 was operated upon for the removal of an intraligamentary cystic ovarian tumor, the size of a man's head. On section the tumor was found to have a papillary structure. In 1895 she was operated upon for recurrence in the right ovary and also for a fist sized abdominal wall tumor which proved to be carcinoma. The author believed that these latter were entirely secondary to the first tumor of 6 years previously.

In 1902 Olshausen again reported another similar case of a woman who in 1881 at the age of 29 years had been operated upon for bilateral tumors of the ovary (bilateral ovariectomy). These were of the papillary cystic type. For the past half year she had noticed a tumor on the right side of the abdominal wall which progressively increased in size. It was removed and diagnosed grossly as unquestionable carcinoma. A histological diagnosis not having been ready at the time of the report. This the author believed arose by inoculation at the time of the previous operation because the abdominal wall tumor was found to arise from the scar of the previous laparotomy.

This last case demonstrates three interesting facts found together which had occurred separately in previous cases, namely a long interval of time elapsing between the removal of the pri-

mary benign ovarian tumor and the appearance of the secondary in the abdominal wall, origin of secondary in the scar of the previous laparotomy wound finally malignancy of the secondary tumor.

Schnuetgen (quoted by Tauber) up to 1918 found only 8 published cases of benign ovarian tumor metastasis to the abdominal wall. To these he added a case.

Bland Sutton (1922) removed the uterus and bilateral apparently benign, papillary ovarian cysts of a woman. Six years later a rapidly growing tumor of the sternum on the right side at the level of the second intercostal space was noticed. It was removed but promptly recurred and eroded away the whole manubrium. This secondary tumor was microscopically exactly like the primary cyst. The patient died. At necropsy, strangely, no recurrence appeared in the abdomen.

Tauber (1927) reported a woman whose abdomen began to swell and fill up with fluid in 1919. She was finally explored. Fluid was removed. It was not known whether a tumor had been found. Her ascitic condition recurred and she was reoperated upon in 1921 when bilateral papillary ovarian cysts were removed together with three smaller ones found on the peritoneum of the anterior abdominal wall below the umbilicus. No trace of malignancy could be found. In 1926 the patient returned with another recurring cystic mass around the umbilicus and entirely within the abdominal wall. This was removed. Histologically the tumor was found to be a malignant ovarian cyst.

Lang mentioned a pseudomucinous cyst which was removed from the left ovary of a 30 year old woman. Two months later a tumor developed in the scar of the previous laparotomy wound which proved to be an adenocarcinoma.

The cases described were all of the pseudomucinous or papillary cystadenomatous type. However a similar course of events has been reported occurring in another type of tumor. Jaquet in 1899, described an ovarian dermoid which was removed from a woman in 1874. Seventeen years later, 1891, an abdominal wall tumor 15 centimeters in diameter appeared, which proved to be cancerous.

These cases 10 in number including our own were all that could be found in the literature in which primary ovarian cysts supposed to be benign at the time of their removal, were later followed by a benign or malignant reproduction of their general structural type in the abdominal wall (in the thoracic wall in Bland Sutton's case). Of these 10 new growths, 6 were observed to be



malignant and 4 benign. The secondary growths were first noticed 21 years after discovery of the primary growth in 1 case, 17 years in 2 cases, 13 years in our case, at least 10 years in 1, 7 years in 1, 6 years in 1, 2 months in 1, and 2 were of undetermined duration. Of the 6 malignant tumors, one appeared 21 years after discovery of the primary lesion, one 17 years, our case 13 years, one 7 years, one 6 years, and one 2 months.

In all the cases the primary ovarian cysts were considered benign when extirpated. Cases have also been reported in which the primary was obviously malignant when extirpated and simultaneously presented secondary malignant metastases to the abdominal wall specifically to the umbilicus. Cullen (1916) collected 9 such cases.

Mayfield (1926) summarized a study of 100 cases of papillary cystadenoma of the ovary and found that these cysts vary both pathologically and clinically in their degree of malignancy. He found that some small cysts were very malignant, and some large ones benign. Benign and malignant areas coexisted. Such variations in degree of malignancy may account for the great variations in time interval between removal of primary and appearance of secondary abdominal wall growths found in the 10 cases in this series. Papillary ovarian cysts especially when bilateral, always arouse a suspicion of malignancy and though no malignant area may have been found microscopically, the feeling frequently obtains that it may have been missed. Bell (1924) says:

'Recurrence and metastases of ovarian papillary cystadenomata is frequent even from tumors which appear anatomically benign. All papillary tumors are potentially malignant. For these reasons it is believed that the most likely explanation in the case reported here is that the ovarian cyst removed 20 years prior to the patient's death was malignant from the beginning even though that fact was not observed or demonstrated at the time.'

In locating the primary source of implantation tumors of the abdominal wall lesions of the gastro intestinal tract and uterus must be considered as well as of the ovaries. The mere fact that ovarian cysts had previously been removed must not be misleading. Polano (1905) collected from the literature reports of 7 cases of malignant abdominal wall tumors arising in laparotomy scars after previous removal of apparently benign ovarian tumors. He added one similar case. Necropsy in the latter revealed the presence of carcinoma of the stomach which he believed was very likely the primary growth. Of the 7 cases collected from the literature, on only one, that of Plan-

nenstiel, was necropsy performed. No intra abdominal cancer was found here. Nevertheless, Polano considered the abdominal wall lesion in this case primary and not subsequent to the ovarian cyst. Because of the findings in Polano's case and because no necropsy was done on the other 6 cases, the suspicion always remained that the abdominal wall carcinomata in these 6 might easily have been secondarily implanted not from ovarian cysts but from carcinomata of some other abdominal organ which was missed at the time of the first operation or developed subsequently.

Brewer (1921) cites the case of a woman, who in 1911 had her uterus, tubes, and left ovary removed because of fibroids of the uterus. In 1910 she developed a tumor of the abdominal wall. Removal proved it to be a pure fibromyoma. The author explained its origin to implantation at the time of the previous operation because microscopically it resembled in all details the original uterine fibromyoma.

Adenomyomata described as endometriomata appear to have been rather frequently observed in the abdominal wall and umbilicus in recent years. Cullen (19) described a case of an adenomyoma of the rectus muscle occurring in a woman who 2½ years previously had been operated upon through an abdominal wall incision to repair a ruptured uterus.

Also Mahle and MacCarty (1920) mention 2 cases occurring in old laparotomy scars and also two cases arising without apparent cause, in the umbilicus.

Lochrane (1923) mentions a case of adenomyoma implanted in the abdominal wall which appeared 4 years after ventrosuspension of the uterus. The tumor was always painful around the menstrual periods. This tumor contained typical uterine glands and smooth muscle. Previous to this (1910) Cullen had already collected 13 adenomyomata of the umbilicus, 4 of which were somewhat doubtful. Ewing (1919) also described cases of adenomyoma of the groin.

Lemon and Mahle (1925) reported 9 ectopic adenomyomata invading the abdominal wall after operation.

Nicholson (1926) reported a case of endometriosis occurring in an old laparotomy scar following a salpingectomy and mentioned 15 such cases reported in the literature following ventrosuspension of the uterus. Not in one case was an anatomical continuity established between the uterus and tumor thus showing that the latter must have arisen by implantation.

Lefevre and Montpellier (1927) described a case and mentioned more than 30 cases now on

record of an endometriosis of the umbilicus Pratt (1927) discussed 42 cases now on record of implanted endometriosis occurring in old laparotomy scars following previous operations, the most frequent type of which was ventrosuspension of the uterus. He added 4 cases.

Sampson (1928) found only 1 case of endometriosis of the abdominal wall following ventrofixation of the uterus with tubal sterilization.

Jacobson (1926) working on rabbits showed that peritoneal implantation of endometrial tissue at a distance from the uterus was most successful during oestrus. From this it might be contended *a priori* that operations on the uterus in the human during or around menstruation are particularly subject to endometrial implantation.

Sampson (1923) offered circumstantial evidence in favor of malignant changes in endometrial tissue in the ovary as the source of certain ovarian cancers.

The literature examined revealed one or two cases of direct extension of a primary uterine adenocarcinoma into the anterior abdominal wall but no implantations following operative removal of uterine carcinoma. Thus, it is seen that fibromyomata, more commonly adenomyomata (endometrioma) arising as primary uterine tumors may be implanted into the abdominal wall at the time of their removal. Such, however, was not the situation in our case.

For purposes of orientation I have included below a brief discussion of abdominal wall tumors as a whole. These divide themselves into two divisions: the abdominal wall in general and the umbilicus in particular.

Malignant tumors of the abdominal wall constitute only a very small proportion of malignant neoplasms. Gurliis (quoted in Zweifel Payr) found among 16,637 cases of malignant tumors in general only 27 malignant tumors of the abdominal wall: 14 sarcomata and 13 carcinomata.

At the University Hospital of the University of Minnesota of 28,013 patients admitted between the years 1910 and 1923, only 9 cases of abdominal wall tumors were found. Of these, 7 were primary: fibroma 1, angioma 1, lipoma 2, hemangioma 1, sarcoma 1, two were secondary—both carcinomata by direct extension and not by implantation.

#### SARCOMA OF ABDOMINAL WALL

Of malignant tumors in the abdominal wall in general, both sarcoma and carcinoma are found. Sarcomata arise from the skin as well as from the fascia and muscle sheaths of the abdominal wall, they may originate malignantly *per se*, or benignly

from a fibroma or naevus, particularly a pigmented naevus, which subsequently undergoes malignant degeneration. The different histological types found are fibrosarcoma, fibromyoma, angiosarcoma, and, according to another classification, spindle, round, and giant cell sarcoma. The spindle cell sarcoma appears to be the most frequent of this group. Von Klot (1921) collected some 408 cases of abdominal wall connective tissue tumors of which he found 268 to be fibromata.

#### BENIGN TUMORS OF ABDOMINAL WALL

Of the truly benign types found here are fibroma, lipoma, angioma, myxoma, fibromyoma, adenomyoma, endometrioma. To these must be added rarer forms like atheroma, teratoma, and dermoid and echinococcus cysts. In this benign group, as von Klot's figures have already shown, the fibroma is not only the most frequent, but also the most important. This holds for abdominal wall tumors in general. Mueller (1838) first applied the name, desmoid tumor, to this group. According to Balfour (1916) they occur in women in the ratio of 7 to 1. The average age is 34 years. They are usually found in the anterior or lateral abdominal wall and in 43 per cent of the cases are associated with the rectus muscle, or its sheath, usually the posterior sheath. They are frequent after repeated pregnancies. They are usually of small size but may equal the size of an adult's head, are usually smooth unless very large, and are ovoid, the long axis in the direction of the muscle fibers. The cut surface shows a wavy white glistening surface of fibers intimately interwoven. Microscopically, they vary from a solid fibrous connective tissue overgrowth to a very cellular actively growing fibrosarcoma. The blood supply is poor as in other fibromata so that necrosis may occur. The etiology is obscure, or may be due to traumatic overstretching and rupture of the rectus muscle sheaths during pregnancy. Prognosis is good. Balfour reported 7 cases of which 2 occurred in previous operative scars.

With respect to the origin of desmoid tumors, Danforth mentioned work done by Loeb in which the latter incised the uteri of pregnant guinea pigs. Shortly thereafter, he got nodular growths in the uterine scar. These could be elicited only in uteri which were pregnant. Such tumors can be considered analogous to desmoids caused by traumatic stretching of the abdominal wall in pregnancy.

#### CARCINOMA OF ABDOMINAL WALL

Carcinoma of the abdominal wall is either primary or secondary. Outside of the umbilical

region, primary carcinoma of the abdominal wall is rare. Secondary carcinoma of the abdominal wall is more common and a primary lesion should always be sought, especially in the gastro-intestinal tract, liver, and female genitalia. The secondary lesions develop by direct extension, by metastasis, or by implantation at the time of previous operation. Such implantations have occurred not only in the scars of previous laparotomies, but according to Williams (1893), also at the site of puncture wounds after frequent tapping of ascites from an ovarian cyst.

#### DIFFERENTIAL DIAGNOSIS

Besides true neoplasms there must also be considered the inflammatory tumors of foreign body reactions, hematoma, rupture of the rectus muscle resulting in bulging of the ruptured ends, and the infectious granulomata of tuberculosis, syphilis and actinomycosis.

Abdominal wall tumors must be differentiated from intraperitoneal and retroperitoneal tumors. This may be done by having the patient lie on his back and having him raise his trunk to the sitting position without aid, thus contracting the abdominal wall muscles. If the tumor disappears completely from sight and becomes impalpable, it lies behind the abdominal wall. If it disappears only to sight but remains palpable and at the same time immovable, it is in the abdominal wall. If it is not at all influenced but remains visible and palpable, it lies either intracutaneously or subcutaneously. Abdominal wall tumors projecting into the abdominal cavity and tumors of intra-abdominal organs projecting outward become easily confused with one another.

Regarding the differentiation of intraperitoneal tumors from retroperitoneal tumors Devan (1924) emphasized the usefulness of inflating the large bowel with air and then percussing the abdomen over the site of the tumor area. If tympany is found, the colon overlies the tumor and the latter is retroperitoneal, if dullness is found the tumor overlies the colon and the former is intraperitoneal. Use of the X ray is always indicated.

#### TUMORS OF UMBILICUS PROPER

Regarding malignant tumors of the umbilicus proper, the sarcoma is considered the most frequent among connective tissue tumors. On the whole it is rare. More frequent is carcinoma of the umbilicus, which is both primary and secondary. Primary carcinoma is of the squamous and columnar type. The squamous type can arise from remnants of the epithelium of the urachus, or ductus omphalomesentericus.

Secondary carcinoma of the umbilicus may arise from any of the abdominal organs. Head (1926) reported an interesting case of primary carcinoma of the caecum with metastases to the umbilicus.

Umbilical cancer, if primary, is usually of the squamous type, if secondary, it is of the columnar cell type and in that case an indication of an internal primary lesion. The histological structure may frequently indicate its exact location.

Of benign tumors there must be mentioned fibroma, fibrolipoma, angioma, mytoma, adenoma, infectious granuloma and inflammation of the abdominal organs.

#### SUMMARY

During the excision of an intraperitoneal malignant tumor, implantation into the abdominal wall may occur. Such an implantation may survive and at a more or less remote date begin to grow and present itself as a neoplasm of the abdominal wall. Such an occurrence is reported in this paper. Fifteen years after the patient's first operation a tumor was removed from the abdominal wall which proved to be an adenocarcinoma on microscopic section. Following X ray and radium treatment, the patient survived for more than 5 years. At necropsy metastases were seen in the spine (fourth and fifth lumbar vertebrae), but no source for the abdominal wall tumor masses was found. Only a few such instances are mentioned in the literature. After a careful search only 9 besides the 1 reported above were found. Most of the tumors originate from ovarian cysts. They are likely to be mistaken for dermoid tumors, as was the case in the instance reported here, unless the possibility of implantation is borne in mind. The subject of tumors of the abdominal wall in general is briefly discussed.

#### BIBLIOGRAPHY

1. BALFOUR D. C. Characteristics of desmoids. *Rail way Surg. J.* 1916 xlii No. 11.
2. BALMGARTEN PROF. DR. MED. Ein Fall von einfachen Ovarialcystom mit Metastasen. *Arch. f. path. Anat.* Bd. 9, 1884 S. 1.
3. BEIGEL H. Recidiv eines papillösen Cystosarkoms der Bauchhöhle. *Arch. f. path. Ana.* xiv 103.
4. BELL E. C. *Outlines of Pathology.* University of Minnesota. Minneapolis 1921.
5. BEVAN A. D. Group of abdominal tumors in which diagnosis is difficult. *Surg. Clin. N. America* 1924 iv 605-617.
6. BREWER G. E. Typical fibromyoma of abdominal wall following hysterectomy. *Ann. Surg.* 1911 lxxv 354.
7. CLEVER T. S. *The Umbilicus and its Diseases.* Philadelphia W. B. Saunders Company 1916.

8. Idem. Case of adenomyoma of the rectus muscle Arch. Surg. 1920 p 278
9. DANTONIS, W. C. Occurrence of new growths in the abdominal wall after laparotomy Surg., Gynec. & Obst., 1929 xxx 175
10. EMMES J. Neoplastic Diseases pp 577, 589 595 Philadelphia W. B. Saunders Company 1919
11. HEAD J. R. Cancer of the umbilicus secondary to cancer of the caecum. Surg., Gynec. & Obst. 1926 xlv 356
12. JACOBSON VICTOR C. The intraperitoneal trans-plantation of endometrial tissue Arch. Path. & Lab. Med., 1926 1 No 2
13. KLOT B. von. Ueber hundegewebige Bauchdecken-tumoren und ihre klinische Bedeutung im Anschluss an einen Fall von Fibrom in einer Appendekto-menarbe Beitr. z. klin. Chir., 1921 cxxix 28
14. LANG. Quoted by R. Tauber
15. LEROUX and MONTPELLIER. Endometriosis of the umbilical region. Bull. de l'Ass. franc. p. l'étude du cancer 1927 xvi 867-871
16. LEMON W. S. and MAHLE A. E. Post-operative invasions of the abdominal wall by ectopic adenomyomas. Arch. Surg. 1925 x 150
17. LOCHRAVE C. D. Endometrial adenoma of abdominal wall following ventrosuspension of uterus J. Obst. & Gynec. Brit. Emp. 1923 iii 213
18. MAHLE and MACCARTY. Ectopic adenomyoma of uterine type J. Lab. & Clin. Med. 1920 v 221
19. MAYFIELD A. L. Papillary cystadenoma of the ovary clinical and pathologic analysis of one hundred cases Northwest Med. 1927 May
20. NICHOLSON G. W. Endometriosis of abdominal scar following salpingectomy J. Obst. & Gynec. Brit. Emp. 1926 p 620
21. OLSHAUSEN R. Impfmestastasen der Carcinome Deutsche med. Wchnschr. 1902 p 750
22. Idem. Ueber Bauchwandtumoren, speziell ueber Desmoide Ztschr. f. Geburtsh. u. Gynaek., 1899 xli 271
23. PFANNENSTIEL. Ueber Karzinombildung nach Ovario-tomien Ztschr. f. Geburtsh. vol. xxviii p 349
24. POLANO OSCAR. Zur Entstehung maligner Bauch-decken-tumoren nach Entfernung gutartiger Eier-stockgeschwuelste p 416 Ztschr. f. Geburtsh. u. Gynaek. 1905 p 56
25. PRATT J. P. Adenomyoma or endometrial implants in the abdominal wall J. Mich. M. Soc., 1927 xxi 82-85
26. SAMPSON J. A. Endometriosis following salpingec-tomy Am. J. Obst. & Gynec. 1928 xvi, 461-499
27. Idem. Endometrial carcinoma of ovary arising in endometrial tissue in that organ Arch. Surg. 1925 x
28. BLAND-SUTTON SIR JOHN. Tumors Benign and Malignant pp 622-626 1922
29. TAUBER R. Maligne Degeneration von Implan-tationen in den Bauchdecken nach Exstirpation Papil-larer Ovarialtumoren Zentralbl. f. Gynaek., 1927 li 1505
30. WAGNER E. Fall von mehrfachen Cysten des Ovariums Peritoneums und des Subcutanen Bindegewebes Arch. f. Heilk. 1864 v 92
31. WILLIAMS J. W. Contribution to the histogenesis of papillary cystadenomata of the ovary Bull. Johns Hopkins Hosp. 1891 ii 149-157
32. Idem. Papillomatous tumors of the ovary Bull. Johns Hopkins Hosp. 1893 iii 1-284
33. ZWEIFEL and PAYR. Die Klinik der Boesartigen Geschwuelste vol. iii Leipzig S. Hirzel, 1924

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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#### LAWSON TAIT

THE untimely death of Lawson Tait, of Birmingham, England, 30 years ago, cut short one of the most notable medical careers of the last century. That he was a genius no one can doubt who will make himself familiar with his contributions to gynecological and abdominal surgery. Though by no means the first to undertake serious operations within the abdominal cavity, he certainly did more to render abdominal section a safe and practical procedure than any other man and is fairly entitled to the honor claimed for him by Dr. William J. Mayo of being 'the father of modern abdominal surgery.'

Tait began his career as a laparotomist at a time when the operation of ovariectomy had been practically abandoned in England. Of the last 30 ovariectomies performed in Edinburgh, where Tait had received his medical training, not a single one had survived. The operation was actually forbidden in some of the leading London hospitals. Syme the leading Scotch surgeon, one of Tait's teachers to the end of his life refused to perform the operation. Tait nevertheless had the courage to

undertake it soon after he began practice in a provincial town at the age of 23, and before he was 26 he had done the operation 5 times. At his death in 1899 at the age of 54 years he had performed several thousand abdominal sections and with a degree of success unrivaled by any other surgeon.

I happened to arrive in Birmingham the morning of Mr. Tait's death from uræmic coma. I had had the privilege of spending a few months with him as a pupil assistant just 10 years before. On alighting from the train I directed the cabman to drive me to The Crescent, Tait's home and private hospital. Instead of doing so the cabman handed me the morning paper, which was in mourning and bore in large black letters across the page the announcement of Mr. Tait's death. Within a few hours the whole city was in mourning for, next to Mr. Chamberlain, Mr. Tait was unquestionably its most distinguished citizen. His fame had brought to him suffering men and women from the ends of the earth. He had many patients from the United States and Canada and from South Africa and Australia. One patient, an American, the wife of a missionary doctor suffering greatly with an enormous ovarian tumor came from the remote interior of Burmah, having been carried several hundred miles on the shoulders of men to reach the nearest railroad station.

My first meeting with Mr. Tait was in his little office at The Crescent. He sat alone behind a small flat topped desk with a flexible speaking tube close at hand through which he dictated to his secretary in another room. As he sat in his chair he gave one the impression of being a man of gigantic proportions. His

shoulders were very broad, his chest thick, and his large head—he wore a number 8 hat—was covered with a thick mass of dark hair which was inclined to curl. His neck was short. His strong facial features and his abundance of wavy hair gave him an almost leonine aspect. When he stood, however, the impression of greatness diminished somewhat as he was scarcely of medium height.

In manner Mr Tait was kindly and courteous but rather short and abrupt. He had the air of a man preoccupied with intense thought. His speech was rapid and incisive. His sentences terse and pointed. He had an unusually large vocabulary and his choice of words was always the best possible. His ordinary speaking voice was pleasant, almost musical. When aroused and vexed, which often happened, he would roar like a mad bull. Tait was one of the most tender hearted men I ever met. He was gentle and delicate in his manner of dealing with patients and scrupulously careful to observe all the proprieties.

Tait had many crotchets and allowed prejudices to warp his judgment and blind his mental vision. He had a particular dislike for



LAWSON TAIT (1845-1909)

Emmett, one of the finest and sweetest of men. I could never discover any reason for this except that he disagreed with him respecting the nature of the pelvic inflammations to which Emmett had applied the term cellulitis. Tait believed the chief seat of these troubles to be the fallopian tubes, which subsequently turned out to be the truth. He carried his opposition to Emmett so far as to denounce everything he taught as error. In one case which I had previously

studied at the dispensary and in which he was preparing to repair, after his rapid fashion, a torn perineum, there was also a badly torn uterine cervix. I asked, "But, Mr Tait, are you not going to repair the cervix before closing the perineum?" "Oh no," he said, "I never pay any attention to Emmett's little crack."

During the several months I was with him he never once repaired a torn cervix although cases of this sort came daily under observation. I doubt if he had any other reason, than his prejudice against Dr Emmett, for thus ignoring lesions of the cervix.

Having some years before when in Vienna

(1883) become acquainted with Billroth's pylorotomy and Woelfler's gastro enterostomy, I one day inquired of Tait why he did not perform these operations. He at once replied, "Pylorotomy is useless because it is never done except for cancer and the cancer always returns. I never do useless operations." The operation of gastro enterostomy he condemned in equally strong terms, declaring that it always resulted in "continuous fecal regurgitation." His attitude toward these operations illustrates one of the weak points in his character. When a prejudice was once established in his mind it was impossible to uproot it and it so blinded him that he was apparently incapable of treating the subject with intellectual fairness.

In a controversy Tait was a dangerous opponent. He was remarkably skillful in repartee and so dexterous a controversialist that he rarely failed to carry off the honors in discussions at medical meetings even when he was in the wrong. Tait enjoyed nothing better than lampooning an adversary, especially one whom he considered worthy of his mettle. On one occasion his opponent was a well known surgeon who, as his colleagues well knew, had for years been combating the inroads of Father Time by the adroit use of hair dye. In discussing Mr Tait's paper the gentleman suggested that too much weight should not be given to his views because of the fact that he was known to be a man of very strong prejudices, whereupon Mr Tait instantly retorted that he had only one prejudice in the world and that was against a man who dyed his hair. This savage sally quite annihilated his opponent.

Mr Tait's animosity against some of his rivals was so great that it was hardly prudent to mention their names. On the one occasion of which I spoke to him of Spencer Wells he launched upon such a vehement outpouring of

barbed criticisms and acrid animadversions I never ventured to mention his name again.

During operations Mr Tait rarely spoke except to utter now and then a monosyllable or two by way of direction to a nurse or the anesthetist. At other times, however, when riding with him in his carriage, as I had often an opportunity to do, or when riding on the cars, Mr Tait was a genial and interesting conversationalist and had apparently an inexhaustible fund of information on any subject that might be broached. Although he did not finish his university course before beginning his study of medicine, his literary work during the early years of his residence in Birmingham as editorial writer for the *Morning Post* had led him into nearly every field of human interest. He had also been a student of biology under Darwin, whom he almost deified.

Mr Tait frequently attended the theater, which he greatly enjoyed, although he often fell asleep and sometimes snored so loudly as to create considerable disturbance. When not occupied he was in fact liable to fall asleep at any time. In riding up to London I have known him to sleep for almost the entire distance sitting bolt upright in a corner of the compartment and snoring loudly. On one such occasion when the customary fog happened to lift for a few moments, allowing the sun to illuminate his face, I managed to get a good Kodak picture of him. Later he allowed me to take another picture as he was in the midst of a surgical operation, his face wearing the intense and rather savage look which it usually had while he was operating. He was very much amused when I presented him with the two pictures mounted on a card labeled "Wide Awake" and "Fast Asleep." This was his first introduction to the Eastman Kodak, then just out, and he became the possessor of one as soon as possible.

Tait was not spectacular in his methods of operating, but in his work he was remarkably quick, neat, accurate, and efficient. His hands were large, his fingers short and thick but remarkably deft. His precise, dextrous, and rapid movements in the performance of an operation was a fascinating spectacle—never a false movement, though he did some extraordinary things. For instance, if in making an incision a spurting artery made a pause necessary for the application of a ligature, he would often catch the handle of his knife between his teeth instead of handing it to an assistant or laying it down. He did everything himself. He rarely allowed the assistant to do anything more than to hold an artery forceps or to support a large tumor while he applied ligatures to the pedicle.

To the writer's knowledge, Tait has seldom been excelled in rapidity and dexterity. Dr "Jimmy" Wood, who was the star operator in Bellevue Hospital when I was a student there in the seventies, used to cut off legs in 30 seconds, and Liston sometimes amputated thighs in 20 seconds. Martin, the famous Berlin gynecologist, did a double salpingectomy in 8 minutes. I saw Tait do the same operation in 7½ minutes. I often noted the time occupied in perineal operations and seldom found it more than 3 minutes, although McKay, who followed me in Tait's service, in his excellent biography makes his time for this operation 5 minutes. On one occasion I held my watch and saw Tait begin and complete an operation for partial laceration of the perineum in just 1½ minutes.

His ordinary method of operating on patients at the Spark Hill Hospital was thus. With his coat off, sleeves rolled up, and wearing a big apron, he stepped to the side of the bed, seized the anesthetized patient, and placed her crosswise on the bed with her hips at the edge, a nurse holding each limb. With a pair of

tissue forceps in one hand and scissors in the other, he dropped upon his knees and with a few quick snips dissected the vaginal flap, made a deep cut on either side, seized a long handled Peaslee needle, and pulled through three or four silkworm gut sutures so placed as to secure good coaptation of the raw surfaces. The whole operation was over in little more time than it takes to describe it.

In operating, Tait always aimed to do as little as possible. His incisions were short, never more than 2 or 2½ inches unless a larger incision was necessary to remove a growth. His aim was to make the incision just large enough to admit his two large fingers. He said he learned this from Baker Brown. He opened the abdomen a little at one side of the median line and took care to avoid dividing the fibers of the rectus muscle. This practice he learned from A. McKenzie Edwards, one of his teachers at Edinburgh.

He was bitterly opposed to the use of the spray which at that time was in great vogue. I got the impression that his opposition to the spray and to antiseptic methods was chiefly based on his dislike of Lord Lister and Spencer Wells. He even refused to allow an application of antiseptics of any sort to the putrefying hysterectomy stumps which were in those days treated extraperitoneally. As a result, the atmosphere of his wards very often closely resembled that of a slaughterhouse. When one day I asked him to allow me to apply iodoform or carbolic acid to lessen the odor of decaying flesh, he curtly replied, "No," and added "I cannot endure the smell of the stuff. I won't have it around." He did soon after begin the use of dry powdered boracic acid, insisting, however, that he used it only to keep the wound dry and not as an antiseptic.

Although Tait did not believe in antiseptics, he emphasized the necessity for cleanliness. This was perhaps his greatest contribu-



tion to surgery as he was really the father of surgical asepsis. He developed a technique which eliminated many of the perils of abdominal section and so materially reduced the mortality of this operation as to greatly enlarge its scope and enhance its usefulness. Men who followed his leadership in England, notably Greig Smith, Monahan and Mayo Robson, and in this country Joseph Price, Howard Kelly, and the Mayos, reduced the mortality rate to such a degree that the operation lost its terrors and soon came to head the list of major operations as a life saving procedure.

Though he opposed the Lister spray, Tait took the greatest care to keep his hands free from infection. If they became soiled at any time with an infectious fluid he refrained from operating for several days, having learned from experience that soap and water and even the use of the antiseptics then employed would not always insure safety. Rubber gloves were of course not in use in those days. Instruments and ligatures were boiled. Sponges after being soaked over night in a one per cent carbolic acid solution were squeezed put into a muslin bag, and hung up to dry. Only boiled water was used at operations.

At the time I was with him Mr. Tait boasted a record of 116 laparotomies with the same number of successive recoveries. The average mortality of the operation in this country at that time was, I believe, about 20 per cent. He attributed his success in ovariectomy to the adoption of Baker Brown's method of dropping the pedicle into the peritoneal cavity instead of treating it externally with the Spencer Wells clamp and introducing a drainage tube. Tait maintained that peritonitis was not likely to occur if the peritoneal cavity was kept dry.

Another reason for Tait's success was no doubt his radical and courageous departure

from the long established method of dealing with the bowels. As late as 1883, Tait still practiced restriction of bowel activity after ovariectomy, insisting that the bowels should be confined for from 10 days to 2 weeks after operation. A little later, however, he made a radical change in his management of the bowels. Before the operation, the patient was thoroughly purged with saline laxatives and starved for 48 hours. After operation, the bowels instead of being confined were moved by enema on the second morning. Thorough evacuation of the colon on the second morning after operation was a dominant feature of the after care of his patients. Drastic measures were used when necessary to secure an evacuation, and no food was given until after the bowels moved.

Tait would not administer anodynes of any sort so long as there was any hope of saving the patient. The patients sometimes suffered cruelly, but they rarely, if ever, received an anodyne drug of any sort unless they became moribund. He said "I never give any drug unless the patient is going to die."

When asked what should be done in cases of peritonitis following abdominal section, he replied "Nothing at all. The patient who has peritonitis after a surgical operation is certain to die. The time to cure peritonitis is before it begins. If the peritoneal cavity is kept well drained peritonitis will not occur. The important thing is to keep the peritoneal cavity free from stagnant fluids. I am not afraid of germs. They cannot grow without food."

The carbolic acid spray of Lister was conscientiously employed by Spencer Wells and his followers, but Tait achieved better results without the spray than others did with it employing otherwise the same technique. Undoubtedly, the abandonment of the Spencer Wells clamp and the use of the short sterile

ligature and the intraperitoneal treatment of the stump introduced by Baker Brown were the chief factors in reducing the mortality rate from the 23 per cent of Spencer Wells' first one thousand cases to less than 5 per cent in the hands of Tait, Bantock, Thornton, and Keith

Tait's views were strongly supported by the doctrine of intestinal toxæmia which Bouchard had recently brought out. Widal, Roux, and other French investigators had recently shown that in certain conditions, particularly stasis, the pathogenic bacteria always found in the colon may become highly virulent and capable of invading the blood stream and the tissues and producing pleurisy, peritonitis, hepatic abscess, pyelitis, and other grave conditions. Roux had produced peritonitis and abscesses with pure cultures of bacillus coli. Tait maintained that these organisms could not develop without a liquid culture medium, and so he not only introduced a drain in every case, but took care to prevent accumulation of liquid in the abdominal cavity by applying suction to the drainage tube at frequent intervals so as to keep the abdominal cavity as dry as possible.

Tait's departure from the orthodox method of dealing with the bowels before and after

laparotomy was doubtless one of his most important innovations. He led the way, however in numerous departures from established methods and in undertaking new surgical procedures which have enormously increased the scope of abdominal surgery.

Tait claimed that he was the first to perform the operation for removal of the ovaries and tubes for the cure of chronic pelvic inflammation. He was first to operate for the removal of gall stones, first to operate in cases of ruptured tubal pregnancy, and the first to remove the uterine appendages for the relief of bleeding fibroids.

With his great intelligence and broad knowledge, Mr. Tait unfortunately gave no attention to personal hygiene. He was a good deal of a gourmand. He possessed an extraordinarily vigorous stomach which made no protest notwithstanding the enormous quantities of foods and wines as well as stronger liquors which he consumed at dinner. His gross eating habits were doubtless responsible for his premature death at the age of 54 after having previously submitted to an operation for removal of renal calculus.

His last medical paper was entitled "The History of a Sore Kidney," his own

JOHN HARVEY KELLOGG

## MOVING PICTURES IN MEDICINE

TO one acquainted with the history of medicine, the rapid development of pedagogic principles in undergraduate teaching has been a source of great interest and pleasure. We have rapidly divorced ourselves from the amphitheater clinic and have brought the student into closer contact with the patient. While graduate teaching has lagged somewhat, yet, even here we are searching diligently for the means of imparting to those detached from medical centers the advances

made in medical science, diagnosis, and treatment. This problem is a difficult one. In both groups the medical profession has eagerly seized upon any method that bids fair to increase the efficiency of teaching.

It was but natural that the moving pictures should be utilized for this purpose. It was also but natural that the early films should be those designed to depict some personal operative procedure produced in an inadequate way by the physician himself. Such pictures have their limitations, but were the logical first step

In the last few years the thinking teacher has realized that the moving picture presents great possibilities in illustrating certain principles of medical science in which it is advisable to combine in a succinct form anatomical structure and function, embryological development, physiological processes, etc. This method of teaching can be utilized to bring to the practitioner of medicine the newer developments of medical science, newer procedures in diagnosis and treatment, the anatomy, physiology, graphic presentations of symptomatology, and principles of treatment. It presents them in a way that is readily understood and remembered by the busy practitioner.

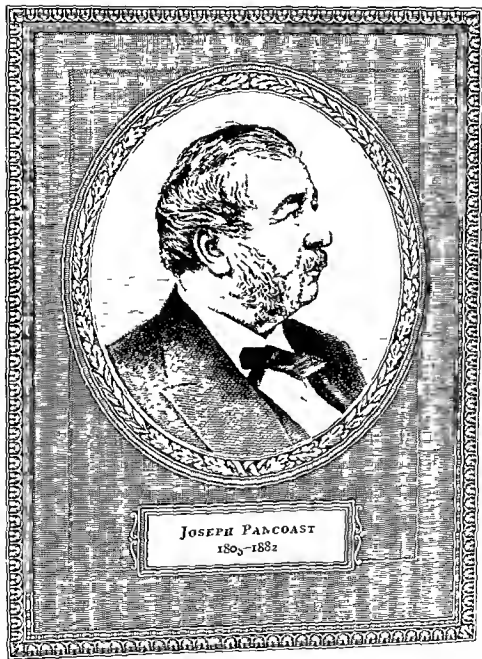
This phase of teaching is in its infancy. The addition of the talking voice in certain cases will add to the clarity of the presentation and serve to emphasize certain principles. The moving picture as such offers a great possibility for the dissemination of scientific knowledge, particularly if those producing them keep constantly in mind the principles upon

which such films should be constructed. The essential criteria should always be "Does the film teach sound, fundamental principles?"

At this stage, we should carefully avoid presenting controversial questions. If this be kept in mind and films are prepared to show the advances of medical science and are made available to the medical profession as a whole, it is probable that moving pictures will become one of the most valuable aids in the dissemination of medical knowledge. They can never replace the experience gained from personal contact with disease, nor can they supplant well established methods of teaching medicine, but as an adjunct to the present medical curriculum in schools and postgraduate study on the part of the practitioner, they should prove of inestimable value.

If such a method of medical instruction is to reach the highest level of efficiency, educational ideals and scientific accuracy must be maintained and photographic technique advanced constantly.





JOSEPH PANCOAST  
1803-1882

# MASTER SURGEONS OF AMERICA

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## JOSEPH PANCOAST

JOSEPH PANCOAST, the son of John and Anne (Abbott) Pancoast, was born near Burlington, New Jersey, November 23, 1805. Nothing is known of his early education. In 1828, he graduated from the medical department of the University of Pennsylvania and immediately began the practice of medicine in Philadelphia, specializing in surgery.

In 1830, the Philadelphia Association for Medical Instruction was formed. This was a quiz organization which consisted at first of Drs. Parrish, Wood, S. G. Morton, John R. Barton, and Franklin Bache. Later Joseph Pancoast was connected with the organization. It was, however, short lived, for at the end of six years it disbanded.

The Philadelphia School of Anatomy was opened by Dr. James Valentine O'Brien Lawrance in 1820. He died in 1823 and the school passed into the hands of the gifted Dr. John D. Godman. In 1826 Godman went to Rutgers College as professor of anatomy and Dr. James Webster assumed charge of the school. Webster accepted in 1830 the chair of anatomy in the Geneva Medical College, and in 1831 Joseph Pancoast, the fourth to take charge of this celebrated school, began his brilliant career as an anatomist and surgeon. On October 7, 1835, he was elected physician to the Philadelphia Hospital (Blockley), and soon after physician in chief to the Children's Hospital in the same institution, from 1838 to 1845 he was one of the visiting surgeons to the same hospital. In 1838 he was called to the chair of surgery in the Jefferson Medical College, made vacant by the retirement of Dr. George McClellan, and gave up his charge of the Philadelphia School of Anatomy.

During the seven years he was connected with the school of anatomy he devoted much time to study and writing. In 1831 he translated Lobstein's *De nervi sympathici humani fabrica et morbis*, Paris, 1823. This treatise contains an account of the first case of Addison's disease on record, though it was not recognized as a distinct disease until Addison published, in 1855, his classical work on the diseases of the suprarenal capsules (Henry). Later he edited Manec's *Great Sympathetic Nerve* and his *Cerebrospinal System in Man* and fitly closed his career in the school of anatomy by editing, in 1838, a new edition of Wistar and Horner's *Anatomy*, to

which he added numerous notes, chiefly histological. This he still further re-modeled in 1842 and again in 1846. For years this was the text used by the students at the Jefferson Medical College until it was supplanted by the excellent manual of Erasmus Wilson which eventually gave way to the familiar "Gray." In 1844 he published his *Treatise on Operative Surgery*, which passed through three editions, the third appearing in 1852. He contributed numerous articles to the *American Journal of the Medical Sciences*, *American Medical Intelligence*, *Medical Examiner*, besides publishing many papers on surgical and pathological subjects, introductory lectures, and, in 1856 his well known *Professional Glimpses Abroad*.

In 1841 Pancoast was transferred from the chair of surgery to that of anatomy which he resigned in 1874, after having filled for 36 years two of the most important chairs in the Jefferson Medical School surgery and anatomy. In 1854 he was elected to the medical staff of the Pennsylvania Hospital and resigned in 1864. He was a member of his state county, and city medical societies, the American Medical Association, Academy of Natural Sciences, College of Physicians of Philadelphia, and of the American Philosophical Society.

Surgery is indebted to Pancoast for a number of new operations. He devised the plow and groove, or plastic suture, by means of which four raw surfaces, the bevelled edges of the flap, and the margins of the groove cut by the side of the nose, to receive the flaps come together. He used this suture in all his rhinoplastic operations with uniform success. He devised a fine needle turned near the point into a hook which he introduced just behind the cornea, through the anterior part of the vitreous humor, between the margin of the dilated iris and the lens. By means of this needle he was able to cut deeply the soft parts of the lens and withdraw along the line of entrance of the needle any hardened nucleus leaving the piece in the outer border of the vitreous humor. The operation was usually followed with little irritation.

For occlusion of the nasal duct in ordinary cases of epiphora he devised a small hollow ivory tube, from which the earthy matter had been removed, which he introduced from in front by a puncture of the lachrymal duct and left it to be slowly dissolved. In bad cases of internal strabismus he found that the tendon of the internal oblique muscle was often encircled by rigid connective tissue and it was only by drawing the tendon out by means of a blunt hook and dividing the tendon that the strabismus could be corrected. In the case of large abscesses lying between the colon and cæcum and in front of the quadratus lumborum muscle, he performed successfully a lumbar operation. By cutting the posterior muscles of the velum palate and dividing any attachment they might have made to the pharynx, he several times restored a voice that had previously been unintelligible.

In empyema he raised a semicircular flap over the ribs, and, puncturing the pleura near the base of the flap, introduced a short catheter down to the inner

end of the puncture and secured it with a string, thus forming a fistulous opening with the movable flap serving as a valve when the catheter was removed. In 1862, he performed, for the first time, division of the trunks of the fifth pair of nerves as they emerge from their foramina, at the base of the skull, as a cure for tic douloureux. He devised an abdominal tourniquet, in 1860, which, by compressing the lower end of the aorta, shut off the arterial blood from the lower limbs, thus preventing death from loss of blood in amputations at the hip joint or high up on the thigh. In cases of extroversion of the bladder he turned down cutaneous flaps from the abdomen and groin over the hollow raw surface of the open bladder. This operation was first performed by him in January, 1868.

"During the last fifteen years of his life writing had no charms for him, and when spoken to on the subject he said he thought he had done enough of that kind of work." Dr. Pancoast married in 1829, Rebecca, daughter of Timothy Adams, of Philadelphia. He died March 7, 1882, in the seventy seventh year of his age, "beloved and honored by all who knew him." WILLIAM SNOW MILLER



# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN M.D. FACS, OMAHA

### THE GYNECOLOGY OF MERCATUS

THE beginning of the sixteenth century found Spain rapidly gaining a rather prominent position in the medical world. There were however many reasons why this position should be more of a medical than a surgical one and a glance over the conditions in Spain at this time will explain them. Spain through Columbus' discovery of America had become one of the greatest maritime nations of the world and also one of the richest. Sea service was that of peace and not of war. Her merchantmen sailed between Spain and the Indies which were presumed to be off the coast of Asia bent on missions of trade and commerce and the days of the Armada bringing sea warfare with them did not come until late in the century. Physicians to care for the health of the sailors and treat them if epidemics arose were much more needed than surgeons to care for wounds and because the doctors who followed the sea were being trained for the future duties required of them surgery was largely neglected.

The great new country which was being opened up abounded in a flora that was new to the medical profession and the pharmacists. As the knowledge of physiology and general hygiene was very meager great faith was placed in medicines and the ample supply of new flowers and herbs coming in from the Indies afforded the investigative members of the medical profession material to experiment with in an effort to find new drugs for various diseases. For example the medical department of the University of Alcalá which had been erected by Cardinal Jimenez de Cisneros the head of the Inquisition became greatly interested in this work and its physicians devoted themselves almost wholly to botany until it became one of the foremost schools in Europe along this line. Relations with other European countries were quite friendly. In the latter years of the fifteenth century the Moor had been driven out and so had the Jew, and those wars were over. With the adoption of her own Inquisition under Ferdinand Spain had obtained the right to settle her own religious questions without consultation with Rome and had thus withdrawn from the European political and religious wars which were raging constantly. The Pyrenees made her more or less inaccessible. The rebellion of the Netherlands was accomplished without much fighting and the war with France, which had never been very active

was concluded in 1559. The necessity for army surgeons under these conditions was not very great and the physicians were able to carry on the surgery necessary to peace time.

These factors helped to make surgery as a specialty unnecessary but there was in addition a positive factor which rendered its study and practice more or less dangerous. Surgery being founded upon anatomy ran counter to the ideas of the Church and Spain having founded its own Inquisition which was hand in glove with the rulers delegated to the Inquisitors the absolute power over its inhabitants in the matter of heresy, Anatomy was thus almost unknown. In Guadalupe there was a school where dissection was permitted by special privilege from the Pope but for the greater part it was neglected. The great Vesalius who came to Spain as personal physician to King Philip II was said to have been unable to find a single skull in all of Madrid.

Medical men of parts were however fairly numerous. One of the most learned of these physicians was Luis Mercado more commonly known as Ludovicus Mercatus. He was born in Valladolid in 1520 and studied medicine at the University there. Later he became professor of medicine at his Alma Mater and in his old age was made *emeritus*. He likewise became physician to Philip II and after his death succeeded to the same position with the next King Philip III. He died in 1606 at the age of 86 years. Mercatus wrote a surgery which was published in 1594 and a treatise on dislocations and fractures which appeared after his death in 1625. His most popular work judging from the number of editions—seven—was his gynecology. It was first published in 1579 at Valladolid then at Venice Basle Madrid and Frankfort and was included in the gynecological collection published in 1583.

The principal interest in this work centers in three chapters the seventeenth chapter of the first book entitled Concerning the Hard and Cancerous Tumors of the Breast and eighteenth and nineteenth chapters of the second book Concerning the Scirrhus Tumor of the Uterus and Concerning Cancer of the Uterus. In these he endeavors to point out the differentiation between benign and malignant tumors of these organs. His knowledge of the subject was considerable and is interesting as it shows a rather advanced point of view for this period.

D E  
MVLIERVM  
AFFECTIONIBVS,  
L I B R I I I I I

*Primus, de Communibus Mulierum passionibus differt  
Secundus, Virginum, & Viduarum morbos tractat  
Tertius, Sterilium & pregnantium } accidentia ad vnguem  
Quartus, Puerperarum & Nutricum } exequuntur*

LVDOVICO MERCATO MEDIC DOCT  
Et in vallis Soletanæ Academia permanente Cathedra  
Professore Auctore

CVM INDICE CAPITVM, TVM RERVM OMNIVM  
LOCVPLETSSIMO



---

VENETIIS, Apud Felicem Valgresium M D LXXXVII



## REVIEWS OF NEW BOOKS

THOSE familiar with Dr Foote's *Minor Surgery*<sup>1</sup> do not need to be told the excellence of the present volume. They will however be interested to know that the clinical sections have been preceded by a concise, complete description of the principles of surgical technique and the operations of minor surgery by Dr Livingston. Dr Foote's lately adopted collaborator and that the senior author himself has preceded the sections on regional surgery with chapters on the general considerations of the different types of pathology—congenital defects and an omphalos wounds, fractures inflammations, infections tumors etc thus giving himself the opportunity of setting forth in one place the points applicable to the particular lesion wherever it may occur and freeing himself of the necessity of repeating them in each section.

With these additions the book emerges as an excellently arranged complete treatise on the principles and practice of minor surgery. The sequence of sections—technique, bandaging general consideration of the types of pathology, and finally the regional sections, in which are set forth the details of diagnosis and treatment could not be improved upon. It insures completeness avoids repetition and facilitates reference.

For students the book is simple and fundamental, for practitioners and younger surgeons it provides easy reference and maintains the practical point of view. Whatever in bacteriology, pathology or other theory is important in diagnosis or treatment is brought out in its proper place and its proper proportion. Treatment is described in sufficient detail so that it can be followed.

The style of both authors is excellent. One is not pained as he is so often by medical texts by grammatical inaccuracies and awkward diction. It is simple terse and epigrammatic. The elucidation of principles and the bringing home of points by quotations from the masters adds greatly to its effectiveness.

J R H

THE little book by Professor Naegeli<sup>2</sup> is an effort to teach an introduction to surgery chiefly by means of pictures. It is based upon the premise which is stated by Professor Garre in the introduction as follows:

General experience and experimental psychology indicate that pictorial illustration is superior to any other didactic method for the purpose of retaining facts in the memory and turning them to practical use.

<sup>1</sup>PRINCIPLES AND PRACTICE OF MINOR SURGERY. A TEXTBOOK FOR STUDENTS AND PRACTITIONERS. By Edward Milton Foote, A.M. M.D., and Edward Macklin Livingston, B.Sc., M.D. 6th ed. New York and London: D. Appleton and Company 1919.

<sup>2</sup>A GRAPHIC GUIDE TO ELEMENTARY SURGERY. By Prof. Dr. Th. Naegeli. Translated by J. S. with M. D. M. R. C. P. Introduction by Dr. C. Garre. New York: Williams Wood and Company 1919.

The reviewer quite agrees with this general principle but is disposed to criticize the manner in which Professor Naegeli has carried it out. If as the author states the book is to serve as an introduction to surgery, it should limit itself to elementary subjects and should not include reference to gunshot wounds of the intestine strangulation of the bowel rupture of the spleen tuberculosis of the spine surgery of malignant growths biliary calculi and so on.

While many of the diagrams are interesting and even striking the treatment of the subject would seem to be almost too elementary for the medical student or practitioner but more suitable as an informational treatise to the laity. F C

MINOR surgery represents a very extensive and important field yet there is little question but that in our didactic and clinical teaching of the undergraduate too little attention is devoted to the "minor operation." Gastro enterostomy or herniotomy intrigue the student or interne more than the treatment of a felon or the removal of a sebaceous cyst yet repeatedly we encounter men who after an excellent interne service are incompetent at such procedures.

The scheme evolved by Christopher in his *Minor Surgery*<sup>3</sup> is logical and interesting. It covers the scope of minor surgery after a method that parallels the plan of a well organized text of general surgery. The first seven chapters cover such general topics as wounds foreign bodies furuncles carbuncles burns and gangrene. The remainder of the text is a regional minor surgery. Beginning with the head injuries, infections tumors and deformities are considered. The same general scheme is used to cover neck trunk extremities anus rectum and genitalia.

There are literally hosts of texts devoted to minor surgery "Manuals" volumes on "surgical handicraft" etc. A large percentage of these are of little value. Either the author aims at brevity and compactness ruins his book, or he makes the fatal error of including too many procedures that may best be left to the domain of major surgery.

Christopher has given us an excellent book on minor surgery. It is beautifully written, the text is profusely and well illustrated. It should be of particular value to the man in a community remote from hospital centers where he cannot easily obtain advice and consultation on many of the so called "minor" but important, surgical lesions.

J R. BLICHENDER

RECENT years have found an ever increasing interest in matters of health. Physicians are anxiously striving to educate the people through

<sup>3</sup>MINOR SURGERY. By Frederick Christopher, M.D. F.A.C.S. Foreword by AL. N. B. KENNEDY, M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Co. 1919.

books, magazines and newspapers while the latter in turn are always searching for material that they can understand. The facts concerning disease are hard to comprehend without some knowledge of the normal action of the human organs and the changes that take place in the organs as a result of disease.

Before reading such books as are written for the public concerning the various diseases one would do well first to become familiar with the ways in which man in the past has recognized and struggled against the diseases that have caused him suffering and contributed to the shortening of his days. With such a background in the history of medicine the nature of disease will become more clear, and the mental response to it more normal.

Medical histories like medical textbooks have been prepared almost exclusively for the use of physicians and others with scientific training. Now we have a book by Dr. Richard H. Hoffmann, called "The Struggle for Health," that has been written in clear simple and understandable language. The book is planned about the lives of the great men who have stood out because of their contributions and discoveries that have cheered and aided men in their struggle toward the goal of health.

Modern times and us making progress in the conquest of disease more rapidly than ever before. Our rapid strides now are in large part made possible by the work that has gone on before. It is a duty as well as a need, for all to acquaint themselves with the battle the great men who have gone before us have waged in the interests of mankind. And I know of no more pleasant way of acquiring this knowledge than by recourse to the book by Doctor Hoffmann.

H. B.

**THE fifth volume\*** of the Oxford Monographs on *Diagnosis and Treatment* again covers its field in an authoritative helpful manner. General methods of treatment including heliotherapy are accurately and explicitly described in a preliminary section. The X-ray picture of the normal chest is given in detail. The volume contains in addition over 150 skiagrams of pathological conditions of chests. These are large sized and are reproduced with remarkable faithfulness thus making the work a valuable fund of information in regard to roentgen studies of the chest. Because of the author's close contact with the bronchoscopic work of Chevalier Jackson this form of diagnosis and treatment is stressed. Pneumonography by lipiodol injection is discussed. One fourth of the work is devoted to pulmonary tuberculosis. The general subject of pulmonary accidents parasitic diseases, and in-

fections of the lung and pleura is thoroughly covered. This work is a valuable compendium for the practical man.

PAUL STARR

As dogmatic with his opinions as he is prolific in his writings Victor Fauchet and his collaborators have given us an excellent résumé of their experience with the mooted treatment of gastric and duodenal ulcers. "Gastrectomy is in principle the only rational form of treatment for gastric and duodenal ulcers. Only through gastric resection will the patient be cured and protected against relapses or life complications. This is Fauchet's opening statement but he admits that there is much divergence of opinion because as he truly states "We do not yet know what an ulcer is what is its nature, pathogenesis or its immediate exciting etiology." He finds clinically that chronic coeliac stasis, appendicitis, cholecystitis, epiploitis, and inflammatory bands usually co-exist with gastric or duodenal ulcers. He also believes that a "germ" of ulcers exist in the presence of hyperchlorhydria and that nothing short of a sufficiently large gastrectomy to remove completely all of the pyloric glands will stop this hyperacidity. Fauchet summarizes his operative indications as follows: In duodenal ulcers (1) with normal or hypo acidity—gastro-enterotomy with invagination or excision of the ulcer (2) with hyperacidity or hemorrhage—duodeno-gastric or simple gastric resection. In gastric ulcers (1) with hyperacidity—gastropyloric resection and gastro-enterostomy (2) with normal or hypo acidity—gastropyloric resection in order to avoid possible secondary cancer.

The chapter on pre-operative care of the patient is detailed to the point of minutiae. How removal of tartar from the teeth or painting the gums with tincture of iodine can prevent pulmonary complications is hard to grasp! One cannot but applaud his physiologic statement that any pre-operative purgation should be discouraged. At present 93 per cent of ulcer patients in Fauchet's clinic are operated upon under regional anesthesia (abdominal wall and splanchnics). Simple excision of the ulcer is condemned and Balfour's cauterization is rarely used. The Pean (Billroth No. 1) technique is adopted in 15 per cent and the Polya in 85 per cent of his cases. The chapters devoted to perforating ulcers is excellent. Post-operative complications and their treatment are fully covered. Chapter VII deals with Fauchet's operative statistics at St. Michel's hospital and analyses of 517 gastro-duodenal operations with a total mortality of 8.7 per cent in the past 2 years improved technique and better selection of the type of operation suitable to a given case has reduced the mortality to 6 per cent. The monograph is filled with valuable information and detailed methods of overcoming abnormal anatomical difficulties.

G. DE TARNOWSKY

\*THE STRUGGLE FOR HEALTH. By Dr. Richard H. Hoffmann. New York: Horace Liveright, 1929.

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LEÇONS DE L'ESTOMAC ET DU DUODÉNUM (ET DE LA VENTRÉ) CHIRURGIE ET TRAITEMENT CHIRURGICAL. By Victor Fauchet, Gustave Laquet, A. Hirschberg. Paris: Gaston Doua & Co., 1928.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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C. JEFF MILLER, New Orleans, *President Elect*

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WILLIAM J. MERFILL

WILLIAM T. SHOEMAKER

FLOYD E. KPEVE

CHARLES F. NASSAU

B. A. THOMAS

## PLANNING FOR THE 1930 CLINICAL CONGRESS IN PHILADELPHIA

THE surgeons of Philadelphia, under the leadership of a strong and representative committee, are developing a highly attractive program of clinics and demonstrations for the entertainment of Fellows of the College and their guests at the twentieth annual Clinical Congress of the American College of Surgeons to be held in that city, October 13-17, 1930. All departments of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, and surgery of the eye, ear, nose, throat and mouth—will be represented in this program.

Clinics and demonstrations will be given at the following hospitals: American Oncologic, American Stomach, Babies, Chestnut Hill, Children's, Children's Homeopathic, Cooper (Camden, N. J.), Evans Dental Institute, Episcopal, Frankford, Germantown Graduate, Hahnemann, Jeanes, Jefferson Jewish, Kensington, Lankenau, Methodist Episcopal, Misericordia, Mt. Sinai, Northeastern, Northwestern General, Orthopedic, Pennsylvania, Philadelphia General, Presbyterian, St. Agnes, St. Christopher's, St. Joseph's, St. Luke's, St. Mary's, Samaritan, Stetson University, U. S. Naval, Wills Eye, Woman's Homeopathic, Woman's Medical College, Woman's Southern Homeopathic. The clinical program will also include demonstrations in the laboratories of the medical schools: Jefferson Medical College, University of Pennsylvania, Temple University, Woman's Medical College.

Operative clinics and demonstrations in the hospitals are scheduled for Monday afternoon at 2 o'clock and for the mornings and afternoons of

each of the following four days. A preliminary clinical program is to be published in the next issue of SURGERY, GYNECOLOGY AND OBSTETRICS.

The subcommittee in charge of the section on surgery of the eye, ear, nose and throat will arrange for a series of clinical demonstrations to be held at headquarters each morning, except Monday, in addition to the clinics in those specialties at the hospitals each afternoon.

Programs for a series of evening meetings are being prepared by the Executive Committee of the Congress. At the Presidential Meeting on Monday evening the president elect, Dr. C. Jeff Miller of New Orleans, will be inaugurated and deliver the annual address. Another feature of that meeting will be the annual Murphy oration in surgery. For the scientific meetings on Tuesday, Wednesday and Thursday evenings, eminent surgeons of the United States and Canada with distinguished guests from abroad have been invited to present papers dealing with surgical subjects of present day importance. At the annual convocation of the College on Friday evening, the 1930 class of candidates for fellowship in the College will be received.

The Congress opens at 10 o'clock on Monday morning with the annual hospital conference in the grand ballroom of the Bellevue Stratford Hotel. An interesting program of papers, round table conferences and practical demonstrations dealing with problems related to hospital efficiency is being prepared. The hospital conference, which will continue on Tuesday and Wednesday, is planned to interest surgeons, hospital trustees,

books, magazines and newspapers while the latter in turn are always searching for material that they can understand. The facts concerning disease are hard to comprehend without some knowledge of the normal action of the human organs and the changes that take place in the organs as a result of disease.

Before reading such books as are written for the public concerning the various diseases one would do well first to become familiar with the ways in which man in the past has recognized and struggled against the diseases that have caused him suffering and contributed to the shortening of his days. With such a background in the history of medicine the nature of disease will become more clear and the mental response to it more normal.

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# SURGERY, GYNECOLOGY AND OBSTETRICS

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## THE REDISTRIBUTION OF RESPIRATION FOLLOWING PARALYSIS OF THE HEMIAPHRAGM

JEROME K. HEAD M.D. CHICAGO

From the Surgical Research Laboratory of the Research and Educational Hospital of the University of Illinois

**I**NDUCTION of paralysis of the hemidiaphragm has become a standard procedure in the treatment of unilateral pulmonary tuberculosis. It is supposed to, and in many instances does, promote healing by decreasing the size of the pleural cavity and by curtailing the respiratory motion of the homolateral lung. It is a means of inducing local rest and collapse. Most logical and most efficacious in basal lesions, it not infrequently produces improvement or even healing of apical disease. That it should do this is explainable upon the basis that practically all of the expansion of the lung in a vertical direction, even of the apex, is dependent upon the descent of the diaphragm.

The results following the operation are far from uniform. Some cases are cured, some improved, many unimproved, and others are made worse. In any given case it is difficult to say what the result of the operation will be. For these reasons it has seemed worth while to investigate the effect of paralysis of the hemidiaphragm upon the distribution of respiration and to seek some explanation of the variable results.

It is an obvious fact that when one half of the diaphragm is thrown out of action the portion of pulmonary aeration which thus formerly accounted for must be made up either by an increased respiratory rate or by a greater expansion of some or all of the remain-

ing thoracic parietes. The tidal respiration must remain constant. Observations upon humans and animals have shown that there is no increase in the rate of respiration. It can be stated, therefore, that paralysis of the hemidiaphragm produces a redistribution of the burden of respiration and that while the movement of certain lung areas may be curtailed that of others is increased. It is of the utmost importance to know the exact nature of this redistribution.

Were there no local mechanical factors which tended to throw a greater proportion of the burden of compensation upon certain lung areas, one could assume that the respiratory center would distribute it equally by causing a greater movement of all of the remaining thoracic parietes. That there are such local factors has, however, long been recognized. In this paper I wish to point out what these are, what is their result, and how variations of pathology can alter and modify them.

### HISTORY

Galen observed that contraction of the diaphragm produced an upward movement of the ribs to which it was attached. This conception persisted until Borelli, from experiments on animals and from mechanical considerations, advanced the theory that its contraction tended to constrict the lower thorax and so to depress the lower ribs. In 1833 Duchenne



executives and personnel generally, and an invitation to attend this conference is extended to all persons interested in the hospital field

Other features of importance for which programs are now being prepared include a symposium on cancer and an all day conference on traumatic surgery at which leaders in industry, education and labor together with representatives of insurance companies, surgeons and hospital administrators will participate

General headquarters for the Congress will be established at the Bellevue Stratford Hotel, corner of Broad and Walnut Streets, where the grand ballroom and other large rooms on the second floor, together with additional rooms on the roof have been reserved for the use of the Congress for scientific meetings, conferences, film exhibitions, registration and ticket bureaus, bulletin boards, executive offices, technical exhibition, etc

In recent years a number of fine large hotels have been built in Philadelphia so that there are now ample first-class hotel facilities available for all who will attend

An application for reduced railway fares on account of the meeting in Philadelphia is before the railway traffic associations, and it seems assured that a rate of one and one half the regular first class one way fare will be in effect from all points in the United States and Canada

#### LIMITED ATTENDANCE

Attendance at the Philadelphia session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics, and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given

A registration fee of \$3.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non transferable, must be presented in order to secure clinic tickets and admission to the evening meetings



Fig. 1 The upper tracing represents the movements of the left the lower those of the right costal margin. At the point X the right phrenic nerve was severed. There followed immediately an increase in the excursion of the right costal margin a decrease in that of the left. Continuous stimulation of the distal end of the severed right phrenic nerve produced a decreased excursion of the right costal margin. On the left both the inspiratory and expiratory levels were raised. Brief stimulation of the nerve during each inspiration produced a decrease in the excursion on the homolateral side—an increase on that opposite.

its insertion in the central tendon. It is maintained in its dome like shape by the negative intrapleural pressure, the pericardial ligaments, the positive intra abdominal pressure and the support of the abdominal viscera. For a considerable distance above its origin its upper surface coheres to the thoracic wall. Neither its origin nor its insertion are fixed points. Contracting thus around an arc in what direction it exerts its force upon the ribs to which it is attached must depend upon the ratio between the height and the breadth of the arch. The higher the dome the more will the pull be upward, the lower the more medianward. At the beginning of inspiration the upward pull must be at its maximum. As respiration proceeds and the ribs rise and the dome descends the median pull must increase proportionately. Resistance to the descent of the dome is thus an obvious factor in increasing the upward pull. On the other hand the cohesion of the upper surface of the diaphragm to the thoracic wall tends to raise the origin of the ribs and so to increase the tendency to a medianward pull. That the pulling apart of these coherent surfaces exerts a definite pull in this direction is evidenced by the phenomenon known as Lytton's sign, the sinking in of the intercostal spaces as the diaphragm is pulled away from them. Another factor to be

considered is that the direction in which a rib will move under application of a force at a certain point is dependent not upon the direction of application at that point but upon the relation of this direction to the axis of the rib which runs through its two attachments to the vertebra.

One is thus confronted with a number of incommensurable factors. From the theoretical consideration one can say that contraction of the diaphragm may tend either to raise or to depress the ribs to which it is attached, that it may act to raise them at the beginning of inspiration to lower them at the end, or that in individuals with narrow thoraces and high diaphragms it may tend to raise them while in those with broad thoraces and flat diaphragms it may tend to lower them.

From observations of thoracic movements in normal individuals Lytton's sign is the only thing that indicates in which direction the force is exerted and this is not conclusive evidence. In most individuals the lower ribs move upward on inspiration but whether this is aided or hindered by contraction of the diaphragm cannot be determined. The inspiratory descent of the lower ribs seen in asthma and other conditions associated with flattening of the diaphragm and increased diaphragmatic action indicates that in these conditions

published the results of numerous experiments on dogs, horses and humans which contradicted the work of Borelli and confirmed the earlier conception of Galen. Duchenne found that in the intact animal stimulation of one phrenic nerve with the galvanic current caused an increased upward movement of the ribs on the stimulated side and that section of the nerve caused a corresponding decrease, but that opening of the abdomen and evisceration produced a reversal of the results. From this he concluded that normally the resistance offered to the descent of the diaphragm by the abdominal viscera, especially the liver, tended to hold up the dome and serve as a fixed point toward which the ribs were lifted as the muscle shortened. Duchenne's experiments were so convincing that for 60 years his conclusions were not disputed. Although Gerhardt maintained that in certain pathological conditions in which the diaphragm was flattened its contraction drew downward the lower ribs it was not until recently (1913) that Hoover seriously questioned the work of Duchenne and presented a mass of clinical and experimental observations in support of the earlier conception of Borelli.

The essence of Hoover's conclusions is that the contracting diaphragm exerts a medianward rather than an upward pull upon the lower ribs and consequently acts as an antagonist of the muscles tending to elevate and spread them. He observed repeatedly in human beings and dogs that paralysis of the hemidiaphragm was followed by an increased upward and outward movement of the lower ribs on the affected side and a widening of the subcostal angle. Stimulation of the nerve caused a narrowing of the lower thorax except in the exceptional instance in the dog where the subcostal angle was very small and the diaphragmatic arch high.

More recently Lemon has stated that neither in dogs nor humans has he been able to observe that section of the phrenic nerve made any change in costal breathing.

In 1926 Roith stated that following paralysis of the hemidiaphragm in the human there was an increased movement of all of the ribs on the affected side. Roith advised section of the upper intercostal nerves to counteract this

in instances in which paralysis of the diaphragm was induced in the treatment of apical pulmonary tuberculosis.

Schnippenkotter, working on the cat, found the intrapleural tension at the base on the affected side the same as on the sound side. At the apex there was a greater excursion on the affected side. He noted also an increased excursion of the ribs on the side on which the diaphragm had been paralyzed and a hypertrophy of the intercostal musculature.

*Paralysis of the hemidiaphragm in the human is followed by an increased movement of the ribs on the homolateral side.* Observation of 200 patients who have undergone the operation of phrenic exeresis has shown that in the majority there is an increased outward and upward movement of the lower ribs on the affected side and always, unless pulmonary disease has greatly contracted the upper thorax, an increased movement of the upper ribs. Thus costal breathing is increased throughout the affected side. Observation of these cases has also shown that this accentuation of upper costal breathing occurs even when basal adhesions or atelectasis prevent it in the lower thorax, thus indicating that the greater movement of these ribs is independent of that of the lower ones and that it is not merely that they are relieved of the normal resistance of the pull of the diaphragm.

It remains to consider why this occurs. The following mechanical factors can be conceived of as contributing to it: (1) removal of the force of the contracting diaphragm from the ribs to which it is attached; (2) changes in the intrapleural pressure; (3) changes in the intra-abdominal pressure; and (4) increased elasticity of the partially collapsed lung.

*The effect of the contracting diaphragm upon the ribs to which it is attached.* What direct effect the contraction of the diaphragm has upon the ribs to which it is attached is uncertain. As we have seen it has been maintained that it raised them, that it tended to depress them, and that it made no change in their movement. From a theoretical point of view the problem presents itself as follows. The diaphragm arising from the six lower ribs, the lumbar vertebra and the ensiform cartilage arches upward and medianward to



Fig. 7. The upper tracing represents the movements of the left the lower those of the right costal margin. At the point X the right phrenic nerve was severed. There followed immediately an increase in the excursion of the right costal margin a decrease in that of the left. Continuous stimulation of the distal end of the severed right phrenic nerve produced a decreased excursion of the right costal margin. On the left both the inspiratory and expiratory levels were raised. Brief stimulation of the nerve during each inspiration produced a decrease in the excursion on the homolateral side—an increase on that opposite.

its insertion in the central tendon. It is maintained in its dome like shape by the negative intrapleural pressure, the pericardial ligaments, the positive intra abdominal pressure and the support of the abdominal viscera. For a considerable distance above its origin its upper surface coheres to the thoracic wall. Neither its origin nor its insertion are fixed points. Contracting thus around an arc in what direction it exerts its force upon the ribs to which it is attached must depend upon the ratio between the height and the breadth of the arch. The higher the dome the more will the pull be upward, the lower the more medianward. At the beginning of inspiration the upward pull must be at its maximum. As inspiration proceeds and the ribs rise and the dome descends the median pull must increase proportionately. Resistance to the descent of the dome is thus an obvious factor in increasing the upward pull. On the other hand, the cohesion of the upper surface of the diaphragm to the thoracic wall tends to raise the origin from the ribs and so to increase the tendency to a medianward pull. That the pulling apart of these coherent surfaces exerts a definite pull in this direction is evidenced by the phenomenon known as Lytton's sign—the sinking in of the intercostal spaces as the diaphragm is pulled away from them. Another factor to be

considered is that the direction in which a rib will move under application of a force at a certain point is dependent, not upon the direction of application at that point but upon the relation of this direction to the axis of the rib which runs through its two attachments to the vertebra.

One is thus confronted with a number of incommensurable factors. From the theoretical consideration one can say that contraction of the diaphragm may tend either to raise or to depress the ribs to which it is attached, that it may act to raise them at the beginning of inspiration to lower them at the end or that in individuals with narrow thoraces and high diaphragms it may tend to raise them while in those with broad thoraces and flat diaphragms it may tend to lower them.

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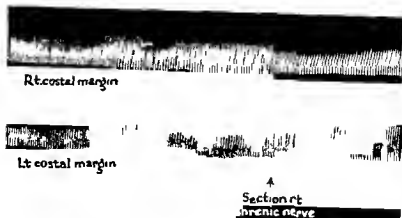


Fig. 2 The upper tracing represents the movements of the right costal margin. The lower those of the left. The arrow indicates the point at which the right phrenic nerve was cut. There followed immediately a decrease in the excursion of the right costal margin.

the diaphragm exerts a downward pull upon the ribs and that this pull is sufficient to overcome the force of the muscles tending to raise them.

Hoover has noted also that conditions tending to raise or hold up one half of the diaphragm such as subdiaphragmatic abscess, are associated with an increased upward movement of the lower ribs on the affected side. Adhesions between the diaphragm and the chest wall have an opposite effect, and I have recently seen a case in which this was so marked on the right side that there was a true paradoxical movement of the lower thorax—the right side moving medianward as the left expanded.

These observations allow one to conclude that when the dome of the diaphragm is lowered or the costal origin of the fibers elevated by adhesions its contraction exerts a medianward pull upon the lower ribs sufficient to overcome the force of the muscles tending to raise them. It allows of no conclusion as to the effect of the contraction under normal conditions but tends to substantiate what was suggested by the theoretical consideration, that the medianward pull increases with the depth of respiration as the dome is lowered and the ribs raised. It must be borne in mind that the actual upward movement of the ribs may be in spite of an antagonistic pull of the diaphragm rather than because of an upward one.

#### ANIMAL EXPERIMENTS

Experiments performed upon dogs have substantiated the findings of Hoover. In animals with broad thoraces and wide subcostal angles, section of the phrenic nerve is followed by an increase in the outward and upward movement of the ribs to which the diaphragm is attached. During stimulation of the distal end of the severed nerve they are drawn downward and medianward (see protocol 1).

In dogs with narrow thoraces and high diaphragmatic arches section of the phrenic nerve is followed by a decrease in the upward and outward movement of the ribs to which the diaphragm is attached. Stimulation of the distal end of the severed nerve produces a brief initial elevation of the ribs and then as the contraction of the diaphragm proceeds a marked downward and medianward movement (see protocol 2).

If adhesions are produced between the diaphragm and the thoracic wall the inspiratory movement of the lower ribs and to a certain extent of the whole hemithorax is markedly reduced. Under these conditions section of the phrenic nerve is followed by a marked increase in the movement of the ribs (see protocol 3).

In the human adhesions between the diaphragm and the chest wall limit markedly the movement of the ribs on the affected side. When such adhesions are present section of

the phrenic nerve is followed by a marked increase in the movement of the ribs, especially of those to which the diaphragm is attached (see protocols 4 and 5)

*The effect of paralysis of the hemidiaphragm upon the intra abdominal pressure* It seemed conceivable that an inspiratory increase in intra abdominal pressure could force outward the lower ribs if they were unprotected from it by a contracting diaphragm. The tracings shown in protocol 6 demonstrate that following paralysis of the hemidiaphragm the intra abdominal pressure becomes slightly negative on inspiration slightly positive on expiration, the reverse of what obtains under normal conditions. This inspiratory negative intra abdominal pressure is slight not sufficient to break the coherence between the diaphragm and the chest wall and while it certainly restricts the upward and outward movement of the lower ribs is too small to be of much importance.

*The rôle of the intrapleural pressure* In humans, as has already been noted, paralysis of the hemidiaphragm is followed by an increased upward and outward movement not only of the ribs to which it is attached, but of those of the whole hemithorax. One would conclude that the greater movement of the upper ribs was because of the removal of the drag of those to which the diaphragm is attached were it not that the increased movement of the former occurs even when local mechanical factors prevent a freer excursion of the latter. Some other factor than the removal of the direct antagonism of the diaphragm must be sought to account for this phenomenon. This factor is I believe the effect of the absence of the contracting diaphragm upon the intrapleural pressure.

If a dog's spinal cord be severed in the lower cervical region paralyzing the intercostal musculature and leaving the diaphragm functioning on each inspiration as the diaphragm descends the ribs are drawn forcibly downward and medianward. They move paradoxically in relation to the diaphragm. This motion is markedly decreased if the pleural cavity is opened widely. This indicates that the paradoxical movement of the ribs is produced by the lowering of the intrapleural pressure

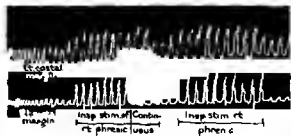


Fig. 3 The upper tracing represents the movements of the left costal margin the lower those of the right. The right phrenic nerve had been severed. Inspiratory stimulation of the distal end of the severed nerve produced a marked increase in the excursion of both costal margins. Continuous stimulation produced a decrease in the excursion of the right costal margin and an elevation of both the inspiratory and expiratory levels on the left.

incident to the descent of the diaphragm. The diaphragm sucks the ribs inward. In normal breathing the decrease in pressure caused by diaphragmatic descent similarly opposes the elevation of the ribs. The muscles raising them are, however, sufficiently strong to overcome this force and their action in turn, by lowering the intrapleural pressure, opposes the descent of the diaphragm. Through the medium of the intrapleural pressure, the diaphragm and the muscles acting to elevate the ribs are therefore direct antagonists. If one is paralyzed the other can act more freely. There is thus a balance between the two sets of muscles and a purely mechanical basis for compensation of the failure of either one.

It has been repeatedly observed that restriction of movement of the ribs on one side of the thorax is followed by increased action of the corresponding hemidiaphragm. It seems reasonable to believe that the explanation offered above accounts for this and also for the increased action of the ribs when the diaphragm is paralyzed.

In this connection one is again confronted with the problem of the effectiveness of the mediastinum as a partition between the two pleural cavities. If pressure changes are transmitted through it from one pleural cavity to the other, paralysis of one half of the diaphragm would affect the movement of the ribs of the opposite hemithorax as much as of those on the same side. In the dog in which the mediastinum is excessively mobile, this

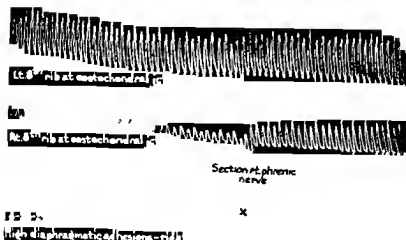


Fig. 4. The upper tracing shows the respiratory excursions of the left hemithorax; the lower those of the right which had been restricted by the production of adhesions between the diaphragm and the chest wall. At the point X the right phrenic nerve was cut. This was followed immediately by a marked increase in the excursion of this side of the thorax.

occurs (see protocol 7). In the human the greater movement of the homolateral side presupposes a difference of pressure in the two cavities, a condition favored by fixation of the mediastinum by disease.

#### EXPERIMENTAL EVIDENCE

In the dog, section of one phrenic nerve is followed by an increased excursion of the upper ribs of both hemithoraces. Stimulation of the distal end of the severed nerve produces a marked decrease in the excursion of these ribs (see protocol 7).

In the dog, section of one phrenic nerve is followed by a rise in pressure in both pleural cavities (see protocol 8).

In the human it has been feasible to test this only in instances in which the paralysis was induced as an adjunct to artificial pneumothorax, and so only on the affected side. In these cases extraction of the nerve was followed by a rise in intrapleural pressure of about 3 centimeters of water. The range of pressure between inspiration and expiration was decreased by 1 centimeter of water (see protocol 9).

To explain the increased excursion of the upper ribs on the homolateral side in humans

on the basis of this change in intrapleural pressure and the removal of this antagonistic action of the diaphragm, one must assume that in the human the mediastinum is a much more effective partition between the two pleural cavities than it is in the dog and that the pressure change is limited to a great extent to the homolateral pleural cavity.

#### CONCLUSIONS

1. In man paralysis of the hemidiaphragm is followed by an increased respiratory excursion of the ribs of the homolateral hemithorax.

2. The intrapleural pressure on the homolateral side is raised by approximately 3 centimeters of water and the range of excursion is decreased by 1 centimeter of water.

3. In dogs with broad thoraces and low diaphragmatic arches the diaphragm in all phases of respiration is a direct antagonist of the muscles tending to elevate and spread the ribs to which it is attached.

4. In dogs with narrow thoraces and high diaphragmatic arches contraction of the diaphragm first tends to elevate the ribs to which it is attached but as the ribs rise and the dome descends the direction of its pull becomes more transverse and it opposes the action of

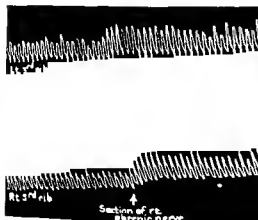


Fig 5 The upper tracing represents the movements of the left third rib the lower those of the right. The arrow indicates the point at which the right phrenic nerve was severed. There followed immediately an increase in the excursion of the ribs on both sides.

the muscles tending to elevate and spread the ribs.

5 In dogs paralysis of the hemidiaphragm is followed by an increased respiratory excursion of the upper ribs of both hemithoraces and by a rise in pressure in both pleural cavities.

6 This increased excursion of the upper ribs is explainable upon the basis that normally the contraction of the diaphragm by lowering the intrapleural pressure opposes the inspiratory elevation of the ribs. Paralysis of one half of it allows them to move more freely.

7 That in the dog the change is noted in the ribs of both sides of the thorax while in the human it is limited to those of the homolateral side can be explained upon the basis that in the human the mediastinum is a more effective partition between the pleural cavities than in the dog and tends to limit the pressure changes to the single pleural cavity.

8 In both man and the dog high adhesions between the diaphragm and the chest wall increase the advantage of the diaphragm as an antagonist of the muscles tending to elevate and spread the ribs and limit markedly their excursion and also the descent of the diaphragm.

9 In the presence of such adhesions induction of paralysis of the hemidiaphragm is fol-



Fig 6 Stimulation of the distal end of the severed right phrenic nerve produced a marked decrease in the movement of the third ribs on both sides.

lowed by an especially marked increase in excursion of the ribs on the affected side and in some cases by an increase in the total vital capacity.

10 Normally the intra abdominal pressure is negative on inspiration, positive on expiration. Following induction of paralysis of the hemidiaphragm it becomes positive on inspiration, negative on expiration.

#### CLINICAL DEDUCTIONS

The observations mentioned, indicating as they do that paralysis of the hemidiaphragm is compensated for chiefly by an increased costal respiration on the homolateral side and so by a greater transverse and anteroposterior expansion of the homolateral lung and showing that this redistribution may be changed by various pathological factors, offer an explanation of the variable results following the operation of phrenic exeresis in the treatment of pulmonary tuberculosis and, by doing this suggest new indications and contra indications to the operation and the advisability of employing accessory procedures to govern the distribution of the compensation.

One can summarize these deductions as follows:



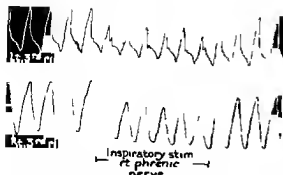


Fig 7 Inspiratory stimulation of the distal end of the severed right phrenic nerve produced a decrease in the excursion of the third ribs on both sides

1 The operation is likely to be most efficacious in the treatment of basal lesions

2 When used in the presence of apical disease one would expect the best results in instances where fibrosis of the lung prevented an increased excursion of the ribs. In other instances the condition could conceivably be made worse

3 Where there are present adhesions between the diaphragm and the chest wall or basal fluid tending to lower the dome, the operation is followed by a great increase in costal respiration in the homolateral lung and in these cases one would anticipate the least beneficial the most harmful results

4 Whenever the operation of phrenico-exeresis is used in the treatment of unilateral pulmonary tuberculosis some accessory procedure should be carried out which has as its result a limitation of costal breathing on the affected side

5 If a procedure is used aiming to limit costal excursion the diaphragm should be paralyzed concurrently

**Protocol 1** The effect of section and stimulation of the phrenic nerve upon the ribs to which the diaphragm is attached. Dog with broad thorax

Male dog of Spaniel type was operated upon under ether anesthesia drop method. Through a small incision low in the cervical region the right phrenic nerve was exposed and a thread run beneath it. The abdomen was then opened and after the normal functioning of both diaphragmatic halves had been verified was closed with silver clips.

The right and left lower costal margins were then exposed through small midaxillary incisions. Thread

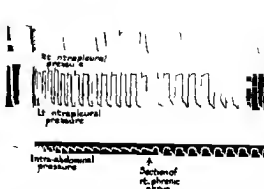


Fig 8 The upper tracing represents the pressure in the right pleural cavity the middle that in the left and the lower the intra abdominal pressure. Section of the right phrenic nerve produced an increase in the pressure in both pleural cavities and an increase in the inspiratory negative pressure in the abdomen

were run from the costal margins downward above the dog's body over pulleys and were attached to muscle levers arranged to write one above the other on a revolving smoked drum. Upward movements of the ribs produced upstrokes of the levers and vice versa. The upper lever recorded the movements of the left costal margins the lower those of the right.

A normal tracing was taken (Fig 1). At the point where the right phrenic nerve was cut. This produced an increase in the excursion of the right costal margin—a decrease in that of the left. Continuous stimulation of the distal end of the severed nerve with the galvanic current produced a marked decrease in the excursion of the right costal margin. The excursion of the left costal margin remained the same but both the inspiratory and expiratory limits were elevated.

Brief stimulation of the nerve synchronously with each inspiration produced a decrease in the excursion of the right costal margin.

Following the experiment paralysis of the right hemidiaphragm was verified by opening the abdomen and observing it directly.

**Protocol 2** The effect of section and stimulation of the phrenic nerve upon the movement of the ribs to which the diaphragm is attached. Dog with narrow thorax

Male dog of Collie type was operated upon under ether anesthesia.

The same experiment was carried out on this dog—one with a narrow thorax and a high diaphragmatic arch.

Section of the nerve produced a decrease in the excursion of the right costal margin (Fig 2).

Stimulation of the distal end of the severed nerve synchronously with each inspiration produced an increased excursion of the right costal margin.

Continuous stimulation of the nerve produced a brief initial increase in the excursion followed by a marked decrease (Fig 3).

**Protocol 3** The effect of section of the phrenic nerve upon the movement of the ribs to which the diaphragm is attached in a dog in which there had been produced high adhesions between the diaphragm and the chest wall

Male police dog weight 10 kilograms was operated upon under ether anesthesia

Through an upper abdominal incision the right dome of the diaphragm was sutured to the chest wall at the level of the fourth rib in the midaxillary line. Three mattress sutures were passed through the diaphragm and the chest wall so that the free ends hung on the outside of the body and that each suture when tied surrounded a rib. The right phrenic nerve was exposed in the neck and the costochondral junction of the two sixth ribs were laid bare for the attachment of the recording apparatus. Threads were fastened to these two points and carried downward above the dog's body and over pulleys and attached to muscle levers in such a manner that an upward movement of the ribs would produce an upward movement of the levers and vice versa. The levers were adjusted to make tracings upon a revolving smoked paper. The upper lever recorded the movements of the left thorax, the lower those of the right. A normal tracing was taken (Fig. 4). This showed a marked limitation of movement of the hemithorax in which the adhesions had been produced. Following section of the right phrenic nerve the movement of the ribs on this side was immediately and greatly increased.

**Protocol 4** The effect of section of the phrenic nerve upon the movement of the ribs in a man with adhesions between the left half of the diaphragm and the chest wall

Mr J. L. a single American laborer of 40 years came to the dispensary of the Research and Educational Hospital complaining of the usual symptoms of pulmonary tuberculosis of 2 years duration. A year before he had developed a pleurisy with effusion on the left which had been treated by repeated aspirations. Physical x-ray and sputum examinations confirmed the diagnosis of bilateral pulmonary tuberculosis. The roentgenogram showed high adhesions between the left diaphragm and the thoracic wall. Examination with the fluoroscope showed no descent of the left diaphragm. On physical examination it was found that movement of the ribs throughout the left thorax was markedly restricted and that on inspiration the lower ribs moved downward and inward paradoxically. He complained of inspiratory pain in this region.

On March 2, 1929 the left phrenic nerve was extracted. Observation of the respiratory movements after the operation revealed a marked increase in the movement throughout the affected side. The lower ribs now moved in the normal direction on inspiration and the pain which had been present previous to the operation had disappeared. There was little if any further elevation of the diaphragm.

**Protocol 5** The effect of section of the left phrenic nerve upon the movement of the ribs in a man with

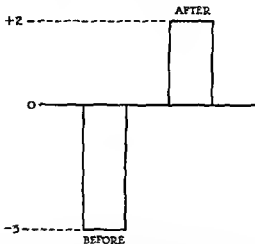


Fig. 9 Diagrammatic illustration of the effect of paralysis of the hemidiaphragm upon the intrapleural pressure in man. Before the operation the pressure ranged between 0 on expiration and -3 centimeters of water on inspiration. After the operation the expiratory level was raised to +2 centimeters of water and the inspiratory level to zero.

adhesions between the left half of the diaphragm and the chest wall

Mr J. C. a single American office worker 30 years of age entered the Research and Educational Hospital of the University of Illinois complaining of a draining sinus of the left axillary region. On the basis of clinical and roentgenological examinations a diagnosis of chronic empyema was made. Following a course of pulmonary irrigations he was operated upon and a cavity was found which was bounded below by the diaphragm and extended upward and posteriorly under the scapula. The ribs and intercostal tissues overlying it were resected and the wound packed. Healing progressed satisfactorily save that a small sinus persisted.

Six months later the sinus was still present and examination at this time showed that on inspiration the area of the old wound was drawn forcibly inward and downward that there was a paradoxical movement of the ribs of the entire lower thorax and that the movement of the upper ribs was markedly restricted. It seemed obvious that these phenomena were caused by the pull of the adherent diaphragm and that this continuous intermittent tug was a factor in preventing healing of the sinus. For this reason the left phrenic nerve was extracted. Following the operation the area of the wound was no longer pulled inward on inspiration and the movement of the upper ribs was markedly increased. The discharge from the sinus was decreased by 50 per cent. The vital capacity which before the operation had been 1,600 cubic centimeters was raised to 1,700 cubic centimeters.

In this case high adhesions between the diaphragm and the chest wall produced a para-

doxical movement of the lower thorax. This was reversed by paralyzing the diaphragm with the result that the vital capacity was increased rather than reduced.

**Protocol 6** The effect of section of one phrenic nerve upon the intra abdominal pressure.

Terrier type female dog ether anesthesia. The abdomen was opened and a rubber tube the end of which was protected by a wire guard was inserted into it. The wound was then closed tightly about the tube. The opposite end of the tube was connected with a tambour manometer arranged to record upon a revolving smoked drum. The right sixth rib was exposed in the midaxilla and a thread run from it downward over a pulley and connected with a muscle lever arranged to make tracings directly beneath the manometer. Inspiration was indicated by upstrokes of the muscle lever. The right phrenic nerve was exposed in the neck.

A normal tracing was taken. This showed that on inspiration the intra abdominal pressure was positive on expiration negative. The right phrenic nerve was then severed. Following this the intra abdominal pressure became negative on inspiration positive on expiration.

**Protocol 7** The effect of paralysis and contraction of the hemidiaphragm upon the movement of the upper ribs.

The dog was prepared in the same manner as was the animal in protocol 1. Threads running to the muscle levers were attached to the exposed third ribs instead of to the costal margins. After a normal tracing had been taken the right phrenic nerve was clamped and there followed an immediate increase in the movement of the ribs of both hemithoraces (Fig. 5).

Continuous stimulation of the distal end of the cut nerve with the galvanic current produced a marked decrease in the movement of the ribs (Fig. 6).

Stimulation on each inspiration had the same effect (Fig. 7).

**Protocol 8** The effect of paralysis of the hemidiaphragm upon the intrapleural pressure.

Collie type male dog ether anesthesia by drop method.

Through a small incision low in the cervical region the right phrenic nerve was exposed and a thread was run beneath it. The abdomen was then opened and after the normal functioning of both diaphragmatic halves had been verified was closed with silver clips. The right and left lower costal margins were then exposed through small midaxillary incisions. A trochar was inserted into each pleural cavity. The two thoracic trochars were connected with tambour manometers arranged to make tracings one above the other on a revolving smoked drum. Below these levers two others were placed one for recording section or stimulation of the nerve and the other the time in seconds. After a normal tracing had been taken the right phrenic nerve was clamped and cut.

After section of the nerve the pressure in both pleural cavities rose. Both the inspiratory and expiratory levels were elevated (Fig. 8).

What seems to be a very slight rise in the intra pleural pressures is when tested by the water manometer about 3 centimeters of water. That it is so small on this record is due to the relative inelasticity of the tambour manometers at the limits of their motion.

**Protocol 9** The effect of paralysis of the hemidiaphragm upon intrapleural pressure in the human.

Mrs. M. C., a married woman 35 years of age had tuberculosis of the right lung for 2 years. A partial collapse of the lung had been obtained by artificial pneumothorax. To supplement this the right phrenic nerve was extracted. Immediately before the operation the pneumothorax needle was inserted into the right pleural cavity and the pressure read from the water manometer. The proximal column of water was -3 on inspiration 0 on expiration. Immediately after the operation it was 0 on inspiration and +2 on expiration. The inspiratory pressure had dropped by 3 centimeters of water and the expiratory by 2 centimeters. The range of pressure change had been decreased by 1 centimeter of water (Fig. 9).

#### ADDENDA

Experiments performed upon rabbits since this article was submitted for publication have shown the following facts:

1. Normal respiration in the rabbit is wholly diaphragmatic.

2. As the diaphragm descends the ribs are drawn downward and medianward.

3. If one phrenic nerve be cut the movement of the ribs is reversed and they rise on inspiration the ribs of the two hemithoraces moving equally.

4. If after one phrenic nerve has been cut the midpoint of the diaphragm is fixed by grasping it with a forceps through the opened abdomen so that it can no longer be drawn toward the sound side the movement of the ribs on the sound side is markedly curtailed on the side on which the diaphragm has been paralyzed markedly increased.

It is probable that fixation of the midpoint of the diaphragm not only prevents the muscle on the sound side from exerting a pull upon the ribs of the opposite side but also that it serves to fix the mediastinum and allow variations of pressure in the two pleural cavities.

#### REFERENCES

1. BORELLI. Cited by Duchenne.
2. DUCHENNE. *Union Medical* 1833 viii 103.
3. GALEX. Cited by Duchenne.
4. GERHARDT. *Ztschr f. klin. Med.* 1896 xxx 3.
5. HOOVER. *Arch. Int. Med.* 1913 xii 214.
6. LEMON. *Arch. Surg.* 1928 xvii 840.
7. ROITH. *Mitt. u. d. Grenzgeb. d. Med. u. Chir.* 1926 xxx 377.
8. SCHNIPPENKOTTER. *Pest. u. klin. d. Tuberk.* 1924 iv 41.

CARCINOMA OF THE SMALL BOWEL<sup>1</sup>

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ALTHOUGH carcinoma of the small intestine is fortunately relatively infrequent, it is not so rare but it is of more than academic interest. In spite of this the subject is practically neglected in the usual works on surgery. It is with the hope in mind that in presenting a composite word picture of a series of such cases, diagnosis will be somewhat simplified. It is an axiom that neoplasia of the small intestine is diagnosed before operation only on rare occasions.

Tumors of the small bowel may be classified as benign or malignant, the benign group includes adenoma, fibroma, lipoma and myoma, the malignant group, carcinoma and sarcoma. Since this paper is to deal primarily with carcinoma of the small intestine we dismiss with a few words the subject of sarcoma. In 1904 Nothnagel in 4,338 necropsies, reported 243 cases of intestinal sarcoma, in 6 of which the growths were in the ileum and in none of which was the growth in the jejunum. On the other hand Comer and Fairbank, in 1905 reviewed 103 cases of sarcoma of the intestine of which 63 per cent were in the small bowel and the largest number of these in the ileum. Occasionally in the literature one runs across reports of single cases of sarcoma of the small intestine, the majority of which are examples of the small round cell and spindle cell types. Soper has recently reported a case of spindle cell sarcoma. The age incidence in sarcoma is between 30 and 40 years.

Concerning the rarity of carcinoma in the part of the intestine between the pylorus and the ileocecal valve Leichtenstern in a series of 780 carcinomata of the intestinal tract found 16 primary in the ileum. Bunting reported one case of carcinoma of the small intestine in 2,200 necropsies. McKenty reported 2 cases in 2,500 necropsies. Johnson reported the statistics of 41,838 necropsies at

the Vienna General Hospital in which 3,583 cases of carcinoma were revealed. 343 of these were intestinal of which 10 were in the ileum and none was in the jejunum. Hinz found that of 584 cases of carcinoma of the intestinal tract 18 were in the small bowel.

It is easy to see from these reports, that there is wide variation in the frequency with which carcinoma of the small intestine is found. This may possibly be due to the care with which necropsies are made, to the individual factor of the physician being able or unable, to recognize the condition, and to the size and character of the clinic or hospital.

Judd in 1919, reported that, in a number of clinics 3 per cent of the intestinal carcinomata was found in the small intestine. At The Mayo Clinic, the incidence of carcinomata from the cardiac end of the stomach down to and including the rectum is approximately 0.062 per cent. Disregarding the type of carcinoma there must be some explanation of the rarity with which carcinoma is found between the pylorus and the ileocecal valve. As in all matters in which the truth is not known there are many theories to account for the facts the chief among which are based on the following characteristics of the small intestine: (1) the fluid nature of its content, (2) the alkalinity of the intestinal fluid and (3) the absence of abrupt bends. In the colon on the other hand the content is of a different nature and stasis also may play a part in the greater frequency with which carcinoma is found. Without an understanding of the etiology of carcinoma one is wise to avoid attempting to explain the reasons why, in one place the disease is found comparatively frequently and in another infrequently. There is not sufficient evidence to warrant the view that carcinoma of the small intestine develops on the basis of embryonic rests or of morbid changes in Brunner's glands.



Fig. 1. Constricting annular carcinoma of the jejunum

Great difficulty was met in reviewing the literature. The main problem lay in detecting the cases in which carcinoid tumors were wrongly classified under the title carcinoma. This fault occurred all too frequently and the effort to glean the actual cases of carcinoma was doubled.

#### MATERIAL

Judd in his paper in carcinoma of the small intestine reported on the cases at The Mayo Clinic up to the year 1919. We carry the report through 1919 to October 1, 1929 (tabulation). Between January 1, 1919 and October 1, 1929 inclusive carcinoma occurred in the small bowel 31 times, as compared with 2,775 times in the large bowel and rectum, and 2,646 times in the stomach. Adding Judd's cases, reported in 1919, there have been 55 cases of carcinoma of the small intestine compared with 4,597 of the large bowel and rectum together, and 4,335 of the stomach.

Only those cases were selected in which from the surgical standpoint, and in a large majority of cases from the pathological standpoint, the carcinoma was primary in the small intestine. Those cases in which carcinoma

was found in the small intestine in combination with carcinoma elsewhere, as in the stomach, large intestine or rectum, were not included. The choice was carefully made in order to fulfill one of the main purposes of this paper, namely, to establish a basis on which diagnosis of primary carcinoma of the small intestine might be made.

#### AGE AND SEX

The average age of patients with carcinoma of the small intestine for the entire group of 55 was 47.5 years. There was however a wide range of variation, the youngest patient was 32 years of age, and the oldest, 69. Eight patients were less than 40 years of age. Kewser, in 12 cases, found the average age to be 43.9 years. Ewing gave the average age as 46.5 years.

Whereas Labey in 1914 found the sexes sharing equally in the affliction, we find 37 males and 18 females. This more nearly coincides with the figures of Venot and Parcelier, 70 per cent males and 30 per cent females.

#### SYMPTOMS OF CARCINOMA OF THE SMALL INTESTINE AS A WHOLE

The individual picture of carcinoma of the small intestine varies but the background remains the same. Variations will be brought about by (1) extent of the local growth, (2) extent and situation of metastasis, (3) individual resistance, and (4) the type and grade of carcinoma (Broders' classification). Since the growth lies in the small bowel the subjective and objective signs and symptoms are chiefly of intestinal origin.

In all cases the chief complaint was "abdominal cramps," "abdominal distress," "stomach trouble," obstruction or other terms carrying the same significance. From this point on in cases of this sort accurate diagnosis rests primarily with the physician and here must be stressed the importance of history taking and of the art of analysis.

In duration of symptoms there is wide variation from 2 or 3 months to 5 years or more. The average in our series was about 14 to 15 months. Factors which affect duration of symptoms are the type and grade of the carcinoma, individual resistance, and so forth.

The onset of symptoms may be frank or insidious. When the initiation of the process has been of average or short duration, the onset of the illness is generally frank and is characterized by a sudden attack of abdominal cramps. The picture then presented is that of acute intestinal obstruction, the main features of which are (1) sudden, severe abdominal cramps, most frequently localized in one of the lower quadrants, (2) gas and varying distention, (3) nausea and vomiting, (4) visible and reverse peristalsis, and (5) borborygmus. This first attack is usually of short duration, a matter of hours, and is followed by complete recovery. Weeks or months may pass before another exacerbation of acute intestinal obstruction occurs. This may or may not be more severe than the preceding attack, but with the advancement in the disease the tendency is for greater severity and shorter intervals between recurrences of the obstruction. Each renewal is sudden and follows a meal. Late in the course of the trouble, there are no intervals of freedom from symptoms; patients always have gastric distress, but have spells of feeling much worse.

Food dyscrasia is a varying factor. Commonly one gets a history which simulates, to a degree, duodenal ulcer or disease of the gall bladder and the patient will say, "Nothing agrees with me." Since, in many of these cases, free hydrochloric acid is lacking from the stomach it is not strange that in some cases there is distress from food. Constipation is more frequently complained of than diarrhoea. When there is a history of diarrhoea, it is found to have alternated with constipation and in this simulates carcinoma of the colon. We find as Johnson and Susman found that constipation in carcinoma of the small bowel becomes increasingly obstinate. Occasionally the history of tarry stools and even of repeated hemorrhages from the bowel is obtained. In the majority of cases however, such a history is not given. In spite of this we re-emphasize the importance of repeated tests for occult blood in the stool.

It may be that the first noticeable change in a patient with carcinoma of the small intestine is slowly developing anemia. The anemia is progressive and it is not unusual for



Fig. 2. Marked ulceration in constricting annular carcinoma of the jejunum.

the victim to present himself for treatment of "pernicious anemia." Often it is only with considerable difficulty that a differential diagnosis can be made in a case of advanced secondary anemia. It does not respond to administration of liver or to other methods of treatment now prescribed. As the anemia creeps on, malaise keeps apace. Suffice it to say that in the presence of unexplained secondary anemia, the possibility of a malignant lesion of the small intestine should be kept in mind. The average concentration of hemoglobin in our series of cases was 59.5 per cent, it was 40 per cent or less in 9 cases. Regardless of the concentration of hemoglobin being higher in some cases than one would expect the appearance of the patient is pale and pasty. The average color index was 0.675 in the 12 cases in which it was taken. The average blood pressure was 118 systolic and 70 diastolic. Considering the mean age as 47.5 years, this is somewhat low.

## GENERAL EXAMINATION

In giving the results of general examination, we confine ourselves to positive features that are directly relative to carcinoma of the small intestine. We discuss secondary signs, such as those referable to the head, neck, thorax, and genito urinary system, not forgetting that they are important in determining risk and prognosis, and that they may be so numerous and serious as to obscure the primary trouble.

The patient is generally anæmic may be cachectic, and has lost some weight. In our series, the average loss was 28 pounds.

The results of abdominal examination depend of course, on the stage of the disease at which it is made. It is not usual at the clinic to see patients in the stage of acute obstruction but undoubtedly most of them are seen by a physician at such times. Therefore it is well to remember the picture of acute high intestinal obstruction and to consider neoplasm of the small intestine as a possibility in its causation. Because the duration of signs of acute obstruction is short (a matter of hours) and because it usually is relieved, we consider mainly the signs that appear in the intervals and that become more marked as the disease progresses. First, inspection reveals visible and reverse peristalsis. Distention is variable but frequently is seen later in the course of the trouble when the obstruction becomes more chronic. Second palpation discloses tenderness and rigidity usually more marked over a given area which changes with the situation of the growth. If a mass is palpable and often one is it is movable and tender unless the growth has broken its bounds and has become adherent to a fixed object. But as a rule when a mass is palpable and movable 'slips away from the fingers' and is tender and when other signs and symptoms are present carcinoma of the small intestine may well be suspected. Third auscultation is not always necessary in order to locate the growth. Gurgling at the point of obstruction may be audible at some distance. *Borborygmus* is a significant observation.

## SPECIAL EXAMINATIONS

In 20 cases analysis of gastric content was done. Of these, in 9 there was no free hydro-

chloric acid, in 4 marked decrease, in 1, hyperacidity (total acidity of 90 and free hydrochloric acid of 70, in terms of cubic centimeters of tenth normal sodium hydroxide), and in the others acidity was average in degree. The situation of the growth seemed to have no connection with these data.

Proctoscopic examination usually gives negative results, although occasionally rectal or anal papillæ or polyps are discovered. The trouble of making the examination is worth while however in order to help rule out disease of the lower part of the bowel.

Roentgenological examination is important from a negative standpoint that is when the patient shows signs and symptoms of some intestinal lesion it is of value in aiding in the elimination from the diagnosis of duodenal ulcer, and of disease of the stomach or colon. An occasional case is diagnosed by roentgenological examination. Crane of The Mayo Clinic some time ago stated that when there was prolonged gastric retention without signs of gastric pyloric or bulbar involvement the suspicion of carcinoma of the duodenum should be aroused.

Portis and Portis in 1923 reported a case diagnosed roentgenologically as a probable case of tumor of the jejunum. The diagnosis was based on the following data: (1) the stomach was negative (2) the duodenum was dilated, (3) the small bowel near the duodenum filled and remained filled giving the appearance of a stomach with an air space above the fluid level (4) the bowel at a point distal to the dilatation was definitely constricted and (5) reverse peristalsis was observed in the dilated portion proximal to the constriction. The surgeon at operation, found an annular growth in the jejunum near the ileum for which resection and lateral anastomosis were done.

Clark reported a case in 1926 in which the lesion was located by roentgenological examination.

Soper, to illustrate the value of roentgenological examination of the small intestine cited 11 cases in one of which there was carcinoma 12.5 centimeters downward from the ligament of Treitz and in one a sarcoma of the spindle cell type 35 centimeters below the

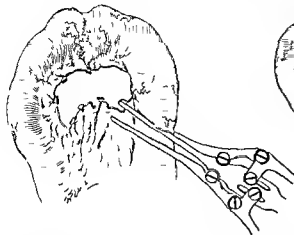


FIG. 3 Application of clamp to one loop of the bowel mesenterically ligated

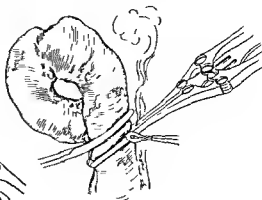


FIG. 4 Both blades of the clamp in place removal of the segment of the bowel with cautery

ligament of Treitz. He stated, in conclusion that intensive study of the course of a barium meal in its passage through the small intestine is necessary in order to establish a diagnosis. We believe that the danger of increasing the obstruction by retention of barium in an already obstructed intestine unless satisfactory means for its removal are available, is a serious handicap to a successful surgical procedure.

#### PATHOLOGY

In the majority of our series of cases the tumors were reported pathologically, to represent the various grades of adenocarcinoma. It is hoped that at a future date we may report in greater detail the pathological aspects of carcinoma of the small intestine. However the two most common forms are those which develop on degenerating polyps and the ring type which simulates the growth commonly found in the large intestine (Figs. 1 and 2).

Bland Sutton in 1914 stated that carcinoma occurred more commonly in the duodenum than in either the jejunum or ileum. We on the other hand find that of these three the highest incidence is in the jejunum with the frequency of lesions in the duodenum and ileum approximately equal. There seems to be no evidence to lead one to believe that carcinoma in the duodenum develops on the basis of chronic ulcer. Judd likewise drew this conclusion.

Mueller recalled, in 1925 the important consideration of carcinoma of the ampulla of Vater. He believed that probably the most common origin of growths in this region was from the duodenal mucosa at the papilla, and also, that carcinoma of any part of the duodenum may involve the papilla by extension. This we have seen in one case, with the intermittent jaundice he described.

In 21 cases (38 per cent), the carcinomata were found in the jejunum. A surprising number of these was at or a short distance from the ligament of Treitz.

In 14 cases the carcinoma was primary in the ileum. At the ileocecal valve it is sometimes difficult to determine whether the growth has extended into or from the ileum. Carcinomata of the ileocecal coil however, are rare; they have occurred at the clinic only seven times in the last 10 years. Recently, a case of localized tuberculosis of the ileum was observed 75 centimeters from the ileocecal valve and the history in many respects was similar to that in carcinoma of the small intestine. This condition must be remembered as one difficult to distinguish from carcinoma except at operation.

#### METASTASIS

Metastasis is a common accompaniment of malignancy in the small bowel. Invasion affects, first, the mesenteric lymph nodes and



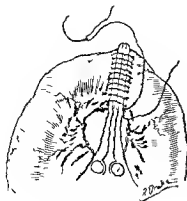


Fig 5

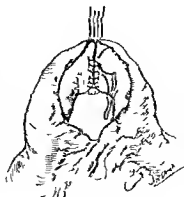


Fig 6

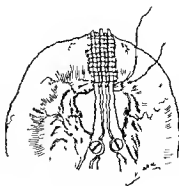


Fig 7

Fig 5 Anterior layer of sutures  
Fig 6 The clamp reversed and the first layer of posterior sutures being applied

Fig 7 Removal of clamps; agglutination holds the edges of the bowel together

peritoneum, then the liver, lungs, long bones, and spinal dura, in order. Metastasis takes place, probably, at an early stage of the disease and obviously influences seriously the undesirable outlook in lesions in this situation. In one in every three of our cases, at the time of operation, there was metastasis which either excluded radical surgical measures, or, if the metastasis was present only in the lymph nodes influenced unfavorably the ultimate outcome.

#### TREATMENT

The treatment of carcinoma of the small bowel when the growth is removable, obviously is resection, with reestablishment of the continuity of the lumen of the bowel. When, because of the attendant obstruction it is not removable or resectable, entero-anastomosis, side tracking the pathological lesion is the procedure of choice. Occasionally one will feel justified in doing resection, with anastomosis in the presence of metastasis since this occasionally may be accomplished in a mobile segment of bowel almost as readily and with as little danger of contamination as a side tracking palliative entero-anastomosis.

In accomplishing resection of a segment of the bowel which is to be rejoined under favorable conditions it has been our practice to employ an aseptic type of anastomosis over a three-bladed clamp, devised by one of us (Rankin) and used satisfactorily in a large series of resections of the large bowel. Path-

ological conditions of the small bowel are so exceedingly rare except for the traumatic lesions that demand resection that opportunity to use this clean method of anastomosis in the small intestine has been relatively infrequent. However we have used it three times in this series establishing an end to end anastomosis in two instances and in one instance lateral anastomosis. The choice between end to end and lateral anastomosis in reestablishment of the continuity of the bowel either large or small is a question and must be settled in each case in accordance with the choice and experience of the individual operator. It is our belief that in most instances and certainly in lesions of the small bowel end to end anastomosis is the method of choice. The advantages of an aseptic type of anastomosis are not satisfactorily established but suffice it to say that, other things being equal the more cleanly two sections of bowel are joined the more satisfactory the outcome should be because of the decreased chances of peritoneal contamination. The clamp method of aseptic anastomosis in our hands, has proved simple and satisfactory (Figs 3 to 10).

In the end to end anastomosis which is the simplest method of joining the bowel the steps are relatively few and easily accomplished. They consist of the following: (1) ligation of the vessels supplying blood to the segment to be removed, (2) application of the blades of the clamp, incorporating a loop of small bowel

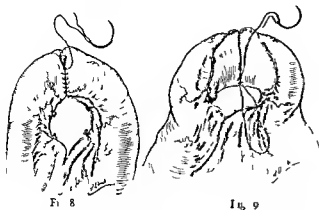


Fig 8

Fig 9

Fig 8 Second row of sutures being applied on the anterior surface  
 Fig 9 Second row of sutures being applied on the posterior surface  
 Fig 10 The operation complete with the fingers breaking out the diaphragm between the loops

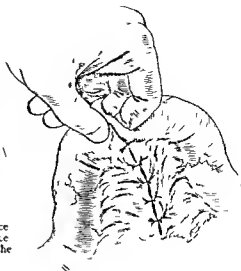


Fig 10

is either blade and, before application, making sure of the blood supply to either end (3) removal of the affected segment with the cautery after applying another clamp above the Rankin clamp, (4) application of a row of sutures around the entire circumference of the bowel before withdrawal of the clamp (5) withdrawal of the clamp and tying of sutures, (6) application of a second row of sutures around the entire circumference of the bowel (7) closure of the mesenteric defect, and (8) breaking out of a diaphragm by invaginating a finger through the anastomosis. If the suture is placed only through the subperitoneal coats the operation of resection may be accomplished absolutely without contamination. The clamp is strong enough to cause sufficient pressure to control hemorrhage from the end cut into in the bowel and agglutination keeps the end of the bowel closed until the suture is drawn taut thus preventing leakage. We have never seen secondary hemorrhage, stricture or leakage in any of our cases in which resection of the large or small bowel has been accomplished by this method. Its simplicity and satisfactory application, we believe, recommend its continued use.

#### PROGNOSIS

The prognosis in carcinoma of the small bowel whether the growth is apparently satisfactory for resection or whether the operation

is palliative is unsatisfactory and the length of life even following resection is short. There is no difficulty in deciding once the abdomen is open, whether or not resection is feasible. Any tumor which is removable should be extirpated whether or not lymph nodes are involved because it is almost as simple a procedure to do an end to end anastomosis in the small bowel as it is to do a sidetracking lateral anastomosis which excludes the lesion. Occasionally blind enterostomy is the procedure of choice in a case of acute obstruction in which one does not feel that even exploration is warranted. This may tide the patient over until a more radical step may be taken. The lives of most of our patients have been short even after removal of the growth. No patient in this series has yet lived longer than 3 years. The range of life of those who have lived was from 1 month to 3 years, and the average was less than a year.

Death comes at an early stage in carcinoma of the small bowel when compared with resectable growths of the large bowel and of other portions of the gastro intestinal tract. Perhaps the digestive activity of this portion of the alimentary canal, the abundant lymphatic supply, and the high grade of malignancy of the neoplasms are important factors in the gravity of the prognosis.

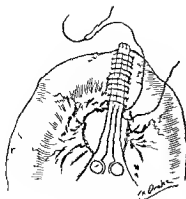


Fig. 5

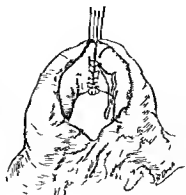


Fig. 6

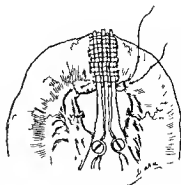


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7 Roentgenological examination is of particular importance only from a negative standpoint in the present state of knowledge, but it seems likely that future progress along diagnostic lines will make the roentgenological examination much more accurate and definite

8 Resection and end to end anastomosis is the surgical procedure of choice. When this is not possible lateral entero anastomosis should be done to short-circuit the obstruction

9 The prognosis is poor regardless of the surgical procedure

10 Metastasis takes place early

#### BIBLIOGRAPHY

- 1 BLAND SUTTON, JOHN On cancer of the duodenum and small intestine Brit M J 1914 ii 653-657
- 2 BURNING C H Multiple primary carcinomata of the ileum Johns Hopkins Hosp Bull 1904 xv 389-394
- 3 CLARK E D Carcinoma of the small intestine carcinoma of ileum Surg Gynec & Obst 1916 xliii 757-763

- 4 CORNER E M and FAIRBANK H A T Sarcomata of the alimentary canal with report of a case Tr Path Soc Lond 1905 lvi 20-42
- 5 HIRZ REINHOLD Ueber den primären Duodenalkrebs Arch f klin Chir 1912 xcix 305-362
- 6 JOHNSON RAYMOND Carcinoma of the jejunum and ileum Brit J Surg 1921 ix 422-430
- 7 JUDS E S Carcinoma of the small intestine J Lancet 1919 xxxix 159-160
- 8 KEYSER C R A case of carcinoma of the jejunum with remarks on malignant disease of the small intestine Lancet 1908 ii 304-306
- 9 LAHEY F H Carcinoma of the small intestine Ann Surg 1915 xii 428-432
- 10 LEICHTENSTERN Ziemssens Handbuch 1888 vii 523
- 11 MCKENY F E Primary carcinoma of the appendix Bull Roy Victoria Hosp 1911 i 56-73
- 12 MUELLER G P Carcinoma of ampulla of Vater Tr Am Surg Ass 1913 xliii 393-400
- 13 NOTHAGEL H Spezielle Pathologie und Therapie 1904 xvii 308
- 14 PORTIS M M and PORTIS S A Carcinoma of the small bowel Am J Roentgenol 1913 x 419-423
- 15 SOPER H W Carcinoma and other lesions of the small intestine J Am M Ass 1919 xcii 286-291
- 16 SUSHAN M P Carcinoma of the small intestine Med J Australia 1918 i 465-467
- 17 VILLOT A and PARCELLER A Le carcinome primitif du jejunum Rev de chir 1913 xliii, 678-712

# CASES OF CARCINOMA OF THE SMALL INTESTINE SEEN AT THE MAYO CLINIC

Situation	Judd's cases	Rankin and Mayo's cases	Total
Duodenum	5	10	15
Jejunum	11	10	21
Ileum	6	8	14
Multiple	2	1	3
Undetermined		2	2
Total	24	31	55

## ILLUSTRATIVE CASE

The patient, a married woman, complained chiefly of cramps, vomiting and anemia of 2½ years duration. At the onset the abdominal cramps had been mild and intermittent, distributed generally over the abdomen and the patient had paid but little attention to them. She had noted a great deal of borborygmus and bloating. She had been mildly constipated for years, but never had gone more than 2 days without a stool. She had not noticed blood in the stool. In the winter of 1927 and 1928 the trouble had become more noticeable, one severe attack had lasted a few weeks and had been accompanied by vomiting. There had been no blood in the vomitus however. Pain at this time had begun in the right lower quadrant of the abdomen and had passed up along the line of the ascending colon and under both costal margins into the thorax.

The patient came to the clinic in September 1928 and was in hospital a week. All roentgenological examinations gave negative results. She was given a diet high in vitamins and liver. Blood was found in the stool on microscopic examination and evidence of blood was obtained by the guaiac test. In October, 1928, after a period of dieting there was not much objective change; she felt better however. In January 1929 cramps persisted to some extent; she was given fetal liver powder, roentgenological examinations gave negative results.

The patient returned home in January and a few days after her arrival severe pain appeared in the right lower quadrant of the abdomen; the pain radiated along the ascending colon to the margin of the ribs and then to the back. The liver powder seemed to bring on the attacks; vomiting and pain ceased with cessation of administration of liver powder. When administration of the powder was resumed, attacks recommenced. She entered a hospital near her home and continuous rolling gurgling and splashing in the abdomen were noted. Following this attack the patient's progress was satisfactory until the attack which caused her to return to the clinic.

Ten days before the patient returned pain had appeared in the upper part of the abdomen. Later the pain had moved downward. Distention with gas pressure against the heart and palpitation, vomiting and visible peristalsis appeared. There was very little evidence of cholecytic disease except vomiting. The patient complained of nervousness

a racing heart and tingling in the feet at night. She had had trouble with bloating at night and had a feeling of pressure in the thorax. There was no gross blood in the stool but erythrocytes were found microscopically.

On examination the patient was found to be anæmic. Otherwise the examination was negative except for the abdomen which was distended and tender (graded 2). On stimulation of the abdominal walls visible peristalsis was easily seen more on the left than on the right and below the umbilicus. A definite mass was not felt; there was borborygmus graded 3. There had been loss of weight of 16 pounds. The blood pressures in millimeters of mercury were 130 systolic and 60 diastolic. Hemoglobin was estimated at 37 per cent and the color index was 0.6. Analysis of gastric content revealed total acidity of 48 free hydrochloric acid of 32 and combined acids of 37. Two roentgenological examinations of the stomach, colon and thorax and one of the gall bladder gave negative results. The test for occult blood in the stool was positive. Certainly obstruction was present but the situation of the obstruction was unknown. Roentgenological examination of the colon gave negative but not conclusively negative results. The diagnosis was as follows: tumor of the small bowel (50 per cent), volvulus (25 per cent) and malignant condition of the colon (25 per cent).

At operation carcinoma at the duodenojejunal juncture, with partial intestinal obstruction was found. Duodenojejunostomy was done with anastomosis between the third part of the duodenum and a point in the jejunum 15 centimeters below the growth. Evidence of metastasis was not found. The growth was not resected because the mesentery was so thick. Four months later the patient was much improved.

## CONCLUSIONS

1. Carcinoma of the small intestine is rare; it represents at The Mayo Clinic, 0.62 per cent of the cases of carcinoma of the gastrointestinal tract.

2. The primary signs and symptoms are directly relative to intermittent obstruction and to secondary anemia.

3. Duration of symptoms varies with the individual case, but the average is 14 to 15 months.

4. A movable tender mass that "slips away from the fingers" should arouse suspicion.

5. The tendency as noted in the history is for constipation to be a rather constant symptom and for it to become increasingly obstinate, although occasionally it is interspersed with attacks of diarrhoea.

6. Repeated tests for occult blood are important in suspicious cases.

weakness and loss of weight in 3 cases, and vomiting in 2 cases. Many patients mentioned other conditions in addition to their chief complaints.

Thirty seven of the patients had a complaint of such indefinite epigastric distress as fullness after meals, belching of gas, and sour stomach.

Thirty seven patients complained of epigastric pain which varied from a burning, gnawing type of pain to definite, severe epigastric pain. Fifteen of these patients gave a history suggestive of peptic ulcer, with periodic spells of distress characterized by the sequence of pain, food, and ease.

The loss of weight ranged from 5 to 70 pounds in a period varying from 2 weeks to several years. The average loss was 23 pounds in 4 months. Eleven of the patients had not lost weight at the time they came to operation.

Twenty six of the patients had demonstrable epigastric tumors. Four of this group, as mentioned, presented themselves at the clinic with the chief complaint of tumor. Some of the tumors were fixed and some moved on respiration. One was palpable only when the patient was in a standing position. One patient had visible gastric penstalsis.

The tumor was situated in the mid epigastrium in 13 cases, to the left of the epigastrium in 11 cases and to the right of the epigastrium in 2 cases. In a few of these cases it was situated below the umbilicus.

The presence of a palpable tumor does not seem to have any evident relationship to the resectability of the lesion or to the prognosis. In 2 of the cases of palpable tumor, the roentgenographic report was of a normal stomach. Sixteen or more than half of the cases of tumor fell within the operable group. Five of the 12 patients who were living when last heard from, one of whom had lived 9 years, were included in the group with palpable tumor.

Sixteen of the patients gave a history of gastro intestinal hæmorrhages for a period of 1 to 9 months. Black, tarry stools were most frequently noted, although a few of the patients had vomited blood. The hæmorrhages were single or repeated. One patient had a

TABLE I—COMPARISON OF FREQUENCY OF SARCOMA AND CARCINOMA

Period	Cases		Ratio
	Sarcoma	Carcinoma	
1905-1915	5	1131	1:226
1916-1920	15	973	1:65
1921-1925	21	1185	1:56
1926-1928	6	821	1:137

fatal hæmorrhage following simple exploration for what proved to be inoperable sarcoma of the stomach.

Twenty seven patients (half of the series) complained of occasional or daily vomiting. Few gave a history of a retention type of vomiting, a few induced vomiting for relief of symptoms.

The concentration of hæmoglobin varied from a high figure of 88 per cent to a low figure of 24 per cent. Forty three patients had a value for hæmoglobin above 50 per cent. In the group of 43 patients with a reading for hæmoglobin above 50 per cent, only 7 had a clinical history of gastro intestinal hæmorrhage. Six of the group of 10 patients with a reading below 50 per cent had a clinical history of bleeding. The ratio between those with a reading for hæmoglobin below 50 per cent to those with a reading above 50 per cent was as 1 to 4.

Determination of the gastric acids was made in 42 of the 54 cases. In this group, free hydrochloric acid was absent in 17. In 25 cases the average reading for free hydrochloric acid in terms of cubic centimeters of tenth normal sodium hydroxide, was 37, the highest value for free hydrochloric acid was 66.

If the 25 cases with free hydrochloric acid be divided into three groups, the following values were found: 0 to 30, with an average of 17, in 17 cases; 30 to 50, with an average of 41 in 5 cases; and 50 or more, with an average of 57, in 3 cases.

Five of the group showed considerable retention of gastric content, the maximal retention was 2,000 cubic centimeters and the average for the 4 cases 1,036 cubic centimeters.

Roentgenological studies were made in 45 of the series and the following diagnoses were

SARCOMA OF THE STOMACH<sup>1</sup>DONALD C BALFOUR M.D. F.A.C.S. AND JAMES C MCCANN M.D. ROCHESTER MINNESOTA  
*Fellow in Surgery The Mayo Foundation*

**R**ECOGNITION of sarcomatous gastric lesions dates back to 1847, when Bruch reported the first case on record. Ewing estimated that sarcomata constitute about 1 per cent of gastric tumors. Haggard reviewed the subject up to 1920 and found that 244 cases of sarcoma of the stomach had been reported in the literature, in 107 of these the patients came to operation. Masson reviewed the cases which occurred at The Mayo Clinic from 1908 to 1920 inclusive, and found 13 proved cases of sarcoma in 2,067 cases of malignant lesions of the stomach, a ratio of 1 sarcoma to 159 carcinomata of the stomach.

This report is a clinical analysis of 54 cases of sarcoma of the stomach which have been studied at The Mayo Clinic from January, 1908 to July, 1929, inclusive. Diagnosis in all of the cases but one was made as a result of surgical intervention for gastric lesions, in the one exception, a sarcomatous lesion of the stomach was found at necropsy. In 5 cases tissue was not removed at operation, the diagnosis was based on the gross appearance of the inoperable tumor. In 3 instances the pathologist reported the possibility of the tissue being cellular carcinoma. In one instance the stoma of a gastro-enterostomy was involved so that there were 45 cases in which a definite diagnosis of sarcoma of the stomach was made and 9 cases in which the diagnosis was 'probably sarcoma'.

The yearly incidence of sarcoma of the stomach as seen at the clinic has not been at all constant. It has varied from 1 to 6 cases a year. There was a similar fluctuation in the ratio of sarcoma to carcinoma during this period, with an average ratio of 1 case of sarcoma to 111 of carcinoma, in a total group of 4,159 cases of malignant lesions of the stomach (Table I).

The ages of these patients were comparable to those reported from other sources. Finlayson reported the youngest patient as  $3\frac{1}{2}$  years of age. Gosset reported the oldest

patient as being 85 years of age. The average age in the cases reported in the literature is about 40 years, whereas the average age of patients with carcinoma of the stomach is 61 years.

In our series, the youngest patient was aged 10 years and the oldest, 67. The average age for the whole group was 43 years. This confirms the opinion of most writers that sarcoma of the stomach occurs earlier in life than does carcinoma of the stomach. The numbers of cases in various age periods were as follows: from 10 to 20 years, 2 cases, from 20 to 30 years, 7 cases, from 30 to 40 years, 7 cases, from 40 to 50 years, 16 cases, from 50 to 60 years, 12 cases, and from 60 to 70 years, 10 cases.

The literature conveys the impression that occurrence of sarcoma of the stomach is equal in both sexes. In our series there were 31 males and 13 females.

In only 4 cases in the series of 54 cases was a history of a malignant lesion in the immediate family elicited. The father of one patient had carcinoma of the stomach, the brother of another patient had carcinoma of the intestine, a third reported that his son had carcinoma of the rectum, a fourth said his mother had carcinoma, the site of which he did not know.

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The average duration of the symptoms of which the patients complained was 18 months. Sixteen of the group had had symptoms for from 2 to 9 years. The average for the remaining 38 patients was only 6 months. The average duration of symptoms in cases that proved to be inoperable was 11 months.

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the growth proved to be irremovable. In the 11 others, the growth had been successfully removed surgically. Ten patients of these 11 are dead. The 4 others represent a third of the 12 patients who are reported as being alive.

Desjardins said that of the sarcomata of the stomach, those which are most favorable for treatment by roentgen ray are lymphosarcomata and that if they could be diagnosed early enough they might be cured by irradiation alone. The basis for the effectiveness of this treatment is that the lymphocytes are more sensitive to the rays than are any other cells of the body. He has shown that if the body of a rabbit is irradiated for an hour, destruction of lymphocytes can be demonstrated.

The extent of the irradiation depends very much on the clinical aspects of the case and is always an individual problem. If the surgeon reports the lesion as limited to the stomach, then irradiation is limited to that region. If lymphatic involvement is reported, then irradiation is extended to the nodes over the omentum and the perigastric region. The question of whether or not to treat peripheral regions is determined by the presence or absence of palpable nodes in those regions. From 1 to 4 courses of treatment may be given to patients as the first series and these may be repeated later as the indications arise.

Definite results are obtained in the treatment of lymphosarcoma. In cases in which the growth has been removed irradiation apparently controls the extension of the process into lymphatic structures. In the inoperable cases, it has definite palliative value, and if irradiation is intelligently given the condition of the patient may be greatly improved for a considerable time. Many patients report marked improvement in their subjective gastric symptoms as well as in their general condition.

The other types of sarcoma, fibro angio sarcoma and myosarcoma, hold little promise so far as the efficacy of irradiation is concerned. The resistance of these tissues to irradiation is much higher than the sensitivity of the tissues of the upper portion of

the intestinal tract. Irradiation for a period sufficiently prolonged to affect such growths would lead to toxic disturbances in the upper intestinal mechanism such as are observed in mechanical intestinal obstruction.

#### PATHOLOGY

The difficulties in diagnosis are not entirely clinical. Experienced pathologists occasionally will hesitate to make a positive diagnosis in cases which prove, by the course of the disease and subsequent pathological examinations, to be sarcoma. In the case reported by Freeman, the specimen removed was sent to several pathologists of note who made diagnoses of carcinoma, lymphosarcoma, inflammatory tissue, and chronic granuloma.

The sarcomata of the stomach in the cases included in this series varied from one about 3 centimeters in diameter in a diverticulum of the stomach to a tumor which involved most of the stomach. Frequently the tumors were situated in the antrum, but usually far enough from the pylorus so that obstruction by the tumors was uncommon. One lesion was reported at operation to be obstructing the pylorus. In one instance the tumor extended from the stomach beyond the pylorus, and into the duodenum. The cardia was never involved. The most common situation of the tumors was on the lesser curvature, but the greater curvature and the anterior and posterior walls were also the site of origin of the lesions.

In the inoperable cases, the tumors were reported as being posterior, involving the pancreas, and also as extending into the omentum. In one instance there was a secondary mass in the pelvis. One lesion, also, was associated with multiple small tumors in the colon.

The mucosa was intact in some cases, whereas in others there was a defect, ranging from a small perforation about 1 millimeter in diameter to an extensive area of ulceration. Frequently, those patients with a history of gastro intestinal hæmorrhages had ulceration or perforation.

The record of gross metastasis does not throw much light on the prognosis of these

made malignant lesion in 35 cases, ulcer in 3, extragastric tumor in 2, possible benign tumor in 1 case, and negative in 5 cases

In these 45 cases in which roentgenological study was done, 8 of the lesions were reported as inoperable. Two of the group, however, were found to be resectable at operation

In 3 of 15 cases in which the lesions were found to be inoperable at exploration, roentgenological studies were not made because of the definiteness of the lesion. In 6 of the 12 other cases, the lesions were correctly reported as inoperable after roentgenological examination

In 38 cases, the lesions were operable, and all of these except 2 were reported as operable by the roentgenologist. These 2 were reported as of doubtful operability, in 1 case the patient has now lived for 6 years and 7 months. This shows the advisability of exploration in cases classified as of doubtful operability by the roentgenologist, if the rest of the clinical study justifies exploration

Most of the clinical diagnoses in the 54 cases were of carcinoma of the stomach. Two of the cases were diagnosed before operation as sarcoma and the roentgenologist called one of the growths a lymphosarcoma, which it proved to be at operation. The clinical diagnoses were as follows: carcinoma of stomach in 30 cases, abdominal tumor in 8 cases, ulcer of stomach or duodenum in 5 cases, benign tumor of the stomach in 3 cases, Banti's disease in 2 cases, pyloric obstruction in 2 cases, cystic gall bladder in 1 case, sarcoma in 1 case, and lymphosarcoma in 1 case

#### TREATMENT

The primary purpose of treatment is removal, and this paper is concerned only with the cases which came to operation. A variety of procedures was carried out as listed herewith: 15 patients in whom the tumors proved to be inoperable were subjected to exploration and none of them is living; 27 underwent the Polya type of resection, 8 of whom are living, 6 underwent sleeve resection and 2 are living, 3 were subjected to excision of tumor and 2 are living; palliative gastro-enterostomy was done for 2 patients neither of whom is living

There are several points connected with the surgical management of these lesions which are important. Seldom, if ever, except in children, is a lesion suspected of being a sarcoma, but in patients in the second or third decade of life a large tumor, known to be in the stomach, should always be suspected of being a sarcoma. Some of these tumors may be so large that surgical intervention appears inadvisable, but even when the roentgenological report suggests that the tumor is inoperable, it is occasionally found to be removable. The reason for this is that certain types of sarcoma are not of an infiltrating type and the line of demarcation of the tumor is definite. Thus the tumor may be so large, and situated so far to the left, as to be mistaken for a splenic or renal tumor and its origin determined only by fluoroscopic examination. Some of the tumors in this series had caused perforation of the stomach and had become fixed to adjacent structures, so that, when the abdomen was opened, the tumors appeared to be irremovable. Nevertheless, in such cases, after separation of the tumor it may be found that the malignant condition has not extended outside of the stomach and removal of the growth can be justifiably undertaken

The methods of resection are essentially the same as those employed for resection of carcinoma. In cases of sarcoma, however, there are more frequent indications for restoring gastro intestinal continuity by antecolic end to side entero anastomosis. More extensive resection can be accomplished in sarcoma than in carcinoma because of the sharper demarcation of the growth in the former

Coley's toxins were administered after operation in 2 of the cases in conjunction with irradiation. Freeman reported a case of lymphosarcoma in which only incomplete removal was possible and in which Coley's toxins and irradiation were used after operation. The patient was alive and well 2 years after operation. Irradiation by roentgen rays alone was used after operation in 14 cases. All of the lesions thus treated were examples of lymphosarcoma with the exception of one case of myosarcoma. In 3 of the 14 cases, simple exploration was carried out,

the cases, a ratio of operability of 66 per cent

Treatment consisted, when possible, of partial gastrectomy followed by administration of Coley's toxins and irradiation by roentgen rays in suitable cases

The tumors varied considerably in size, and several types of sarcoma were reported by the pathologist. Neither the type of tissue nor the presence of metastasis threw much light on prognosis

The immediate operative mortality for the whole group was 11.3 per cent

The postoperative duration of life in the cases in which only exploration was done averaged 4 months. The average duration of life after operation of those patients who underwent resection and have died was 11 months. The average postoperative duration of life for the 12 patients who were living when they were last heard from has been 5 years, 1 has lived for 9 years

cases Of the patients now dead nodes were reported to be uninvolved in 4 whereas in 11, lymphatic involvement was reported Of the patients now living (excluding those of the last 2 years) nodes were reported to be free of involvement in 6, and in 6 there was a report of lymphatic involvement In only 1 case in the series was involvement of the liver evident by the presence of nodules Extension of the lesion into the serosa, as shown by microscopic study, did not throw especial light on the prognosis Two of those patients in whom such extension was found are included in the group of patients who are living

Histological study of removed tissue was made in all but 5 cases In these 5, the diagnosis was made on the definite appearance of the gross lesion In 3 of the 49 cases in which tissue was submitted for diagnosis, the pathologist reported the possibility of the lesion being cellular carcinoma In 1 other case, that of a sarcoma of the stoma of a gastro enterostomy, the jejunum was involved apparently more than the stomach Therefore in this series there are 45 cases in which operation was performed and in which the diagnosis was based on definite histological study of the tissue The following pathological diagnoses were made lymphosarcoma in 32 cases, fibro-sarcoma in 5 cases myosarcoma in 3 cases angiosarcoma perithelial angiosarcoma and spindle cell sarcoma in 1 case each and sarcoma in 6 cases

Of the 12 cases in which the patients were living when last heard from the diagnosis was lymphosarcoma in 7, in the 5 remaining cases it was fibrosarcoma angiosarcoma perithelial angiosarcoma spindle cell sarcoma and sarcoma, respectively The ratio of lympho sarcoma and fibrosarcoma among the patients who are living is about the same as that in the whole series Therefore, a conclusion as to their relative malignancy cannot be drawn

#### RESULTS

The number of immediate deaths following operation in the whole series of 53 cases was 6 (11.3 per cent) One of these deaths resulted from hæmorrhage following simple exploration

The immediate mortality in the cases subjected to direct surgical procedures on the

stomach was 5 deaths in 38 cases (13.5 per cent) Two of these deaths were due to pneumonia without other complications, and 3 to peritonitis

The group in which simple exploration was done comprised 15 cases The youngest patient was 16 years of age the oldest 6 the average age was 41 The pre-operative duration of symptoms in this group was 11 months The group included most of the cases in which tissue was not taken for diagnosis, as the diagnosis appeared substantially correct by inspection The duration of life after the exploration averaged 4 months The longest duration of life was 11 months One patient lived only 2 days death was due to spontaneous hæmorrhage

Of the 38 patients from whom removal of the growth was accomplished 12 were living when last heard from and 26 were dead The average postoperative duration of life for those who died was 11 months the shortest duration was 3 months and the longest 7 years and 3 months

Of those living when last heard from the average postoperative duration of life has been 5 years The longest duration of life when the patient was last heard from was 9 years

#### SUMMARY

A clinical analysis of 54 cases of sarcoma of the stomach seen at The Mayo Clinic from January 1908 to July 1919 is offered In all but 1 case the patient came to operation The average age of the patients at the time of diagnosis was 43 years There was a preponderance of males over females in a ratio of 23 to 1 In only 4 instances was a family history of malignant disease elicited

The average duration of symptoms before operation was 18 months The presenting complaints were dyspepsia pain tumor bleeding weakness and vomiting Thirteen patients gave a history of gastrointestinal hæmorrhage Free hydrochloric acid was present in the gastric content of 60 per cent of the patients The majority of lesions were diagnosed as carcinoma of the stomach before operation was performed The tumor could be removed surgically in 36 of the cases it could not be removed in 15 of

III (moderate anæmia) Those patients with erythrocyte counts between 3.0 and 2.6 million form Group IV (severe anæmia) All patients with counts of 2.5 million or less fall in Group V (very severe anæmia)

Chart 1 indicates that in a study of one thousand pregnant women, regardless of the period of gestation, 47.4 or 47.4 per cent showed a moderate to a severe anæmia (below 3.6 million), whereas only 16.1 or 16.1 per cent had an erythrocyte count above 4 million.

The analysis of erythrocyte counts in relation to trimesters of pregnancy is shown in Chart 2. In the first two trimesters only 12.1 patients were available for study. Of this group 30 or 24.7 per cent manifested a moderate to a severe anæmia (below 3.6 million). Of the 722 patients examined in the third trimester, however, 41.0 or 56.7 per cent had a moderate to a severe anæmia, while 34 or 21.7 per cent of the 157 women examined during labor gave erythrocyte counts below 3.6 million. The preponderance of evidence shows anæmia to be most marked during the third trimester.

In Chart 3 hæmoglobin estimations during gestation are depicted. It is to be seen that a distinct hæmoglobinæmia (70 per cent or less) occurred in 58.6 patients or 58.6 per cent, whereas only 12.9 or 12.9 per cent of the women had a hæmoglobin percentage above 80.

Those patients with 70 per cent hæmoglobin or less were grouped according to the number of previous pregnancies. This was done so as to determine if any relationship exists between parity and the hæmoglobin deficiency. This grouping revealed that 28.5 of the patients were primigravidae while 7.15 had previously borne children. Of the 28.5 women pregnant for the first time, 16.4 or 54 per cent had a hæmoglobin estimation of 70 per cent or less, whereas 4.22 or 58 per cent of the multigravidae gave a percentage of 70 or less. Parity seemingly was not related to the low per centages of hæmoglobin.

Over 70 per cent of the patients were between the ages of 20 and 30. The anæmia was just as prevalent in the young women as in the older groups.

In making a microscopic examination of the blood, the usual changes of a secondary anæ-

TABLE I—ONE HUNDRED PATIENTS WITH TWO COUNTS IN PREGNANCY

No. of Patients	Millions of red blood cells per c. mm. in first two trimesters	Counts at term		
		Unchanged	Decrease 100,000 or more	Increased 200,000 or more
20	4 or over	2	15	3
35	3.9 to 3.6	13	12	9
30	3.5 to 3.2	8	12	20
9	3.0 or less	3	1	6
100		21	41	38

mia were in evidence, such as anisocytosis, polychromatophilia and poikilocytosis. The color index was less than 1.0 in every case.

#### COURSE OF ANÆMIA DURING PREGNANCY

To ascertain if any improvement occurs in the anæmia with the advance of pregnancy, counts were performed on 100 patients in the first two trimesters and again at term.

Table I reveals that 55 patients gave counts above 3.5 million prior to the seventh month. Of this group 28 or almost 50 per cent showed a decrease of 200,000 or more red cells at term. Of the 45 anæmic patients, only 13 or 28 per cent exhibited a similar decrease, whereas 26 or 58 per cent underwent a definite improvement. Thus, it appears that only those patients with a distinct anæmia in the early months of gestation showed any improvement at term. Patients becoming more anæmic with the advance of pregnancy should be observed carefully for evidences of serious disturbances in the blood forming organs.

#### ERYTHROCYTE COUNTS IN THE PUERPERIUM

The erythrocyte counts of 200 patients were performed within 48 hours after delivery and again 7 to 10 days postpartum in order to determine the immediate effect of childbirth. It is to be noted from Chart 4 that of the 106 patients with a moderate to severe anæmia, 16 per cent displayed a further reduction in the number of red cells immediately after delivery, whereas 58.4 per cent showed a marked rise. Of the group of 94 patients with normal counts during pregnancy (over 3.5 million), a much larger percentage (73.4 per cent) manifested a reduction shortly after labor.

Chart 5 denotes the marked improvement occurring 7 to 10 days after delivery, 72.6 per

## THE "PHYSIOLOGICAL" ANÆMIA OF PREGNANCY

## A STUDY OF ONE THOUSAND PATIENTS

P BROOKE BLAND M D, F A C S LEOPOLD GOLDSTEIN M D AND ARTHUR FIRST M D PHILADELPHIA  
 From the Department of Obstetrics Jefferson Medical College Hospital Philadelphia

**I**N an earlier investigation (4) of the blood content in 300 pregnant women made by the writers, it was found that a deficiency in the number of red corpuscles and in the hæmoglobin content is not of unusual occurrence, being present in approximately one half of this class of patients. The present study has been extended to include a much larger number of gravid patients. Herewith is reported in systemized form the results of the blood counts and hæmoglobin estimations in one thousand gravid women in the different trimesters.

During the past 2 years routine hæmatological examinations were made on all gravid women in our antenatal clinic. These examinations consisted of erythrocyte, leucocyte and platelet counts, hæmoglobin estimations together with Wassermann and blood sedimentation tests. The results of the platelet determinations and of the blood sedimentation tests have been analyzed at some length in previous publications (5, 6).

The patients herein studied were of the ordinary clinical type, coming mostly from the tenements of the city and enjoying none of the advantages of luxury and wealth. Not one of these patients, however, had any complicating diseases at the time the count was performed.

The Thoma hæmacytometer supplied with the Lertz counting chamber and the Neubauer ruling was used in the enumeration of the erythrocytes. For the hæmoglobin determinations, the Dare hæmoglobinometer was employed, as it is believed to be sufficiently accurate for our purpose.

In the present study, the normal low limit for the red cells is set at 4.0 million per cubic millimeter, and for hæmoglobin content at 70 percent.

## REVIEW OF LITERATURE

Nasse, in 1836 was the first to point out that the erythrocyte count was physiologically reduced during gestation. Besides the

"physiological" anæmia of pregnancy, two other types of anæmia occur occasionally in the gravid state: first, the pernicious type described by Channing in 1842 and, second, the severe hæmolytic anæmia discussed by Rowland, Allan, and others.

Numerous authors (Fouassier, Meyer, Bluenthal, Kuehnelt, and others) have shown that pronounced anæmia occurs frequently in pregnancy. Thompson claims it is most marked in the first and last trimesters of pregnancy. Gram in a study of 59 pregnant women made the average hæmoglobin estimate of between 71 and 79 per cent throughout gestation. Alder noted an average hæmoglobin of 50 per cent in a study of 11 patients. Kerwin and Collins observed a similar hæmoglobin anæmia. Lyon reported that 38 per cent of the women examined in the last trimester had a hæmoglobin content below 70 per cent. Gallo way found an anæmia existing in all three trimesters of pregnancy.

The question whether the anæmia improves with the advance of gestation is still a disputed point. Kuehnelt observed that a distinct improvement took place after the thirtieth week.

The progress of anæmia in the puerperium has been investigated by Fehling, Rucker, Givco, Meyer, Dubner, Sieben, and others who contend that there is an even greater degree of anæmia shortly after labor with a subsequent improvement and that within 2 weeks after delivery the count rises higher than during pregnancy.

## RESULTS OF ERYTHROCYTE DETERMINATIONS

For the purpose of clarity the patients were divided into five groups according to the severity of anæmia manifested. The patients with counts of 4 million or over comprise Group I (normal count). Those with counts between 3.9 and 3.6 million form Group II (mild anæmia). The patients with counts between 3.5 and 3.1 million comprise Group

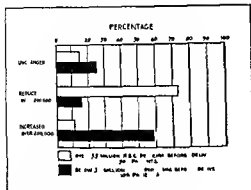


Chart 4 Erythrocyte counts 24 to 48 hours after labor in 200 patients

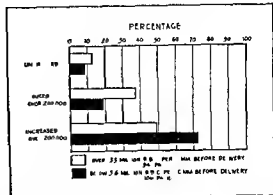


Chart 5 Erythrocyte counts 7 to 10 days postpartum in 200 patients

1 The hypothesis advanced by Audral and others that the anemia is due to chlorosis, is a possible explanation

2 The contention of Kiwisch, Willcocks, and others, that there is a serous hydrops in pregnancy brought about by increased glandular activity, is also tenable. They believed that the relative deficiency was due to a progressive enlargement of the vascular area during gestation and to a large increase in the water of the plasma. This dilution of the blood might manifest itself in a lowered cell count, even though the erythrocytes were not actually reduced in number.

3 The belief that the anemia occurs only in the weak and undemourished gravid women, in those deprived of proper dietetic and medical treatment, is especially supported by Peter, Fehling Meyer, and Schroeder. The statistics published in our previous study, however, revealed that private patients coming from an environment conducive to good health likewise exhibited some anemia in pregnancy though not as severe as in the ward patients. From this observation, it is plausible to suppose that pregnancy itself had brought about the anemia. Furthermore the marked improvement occurring 2 to 6 months after delivery in most of the ward patients tends to substantiate the anemic influence of pregnancy.

4 The theory of Hofbauer states that a syncytial hemolysin in the ectodermal cells of the chorion caused the maternal blood destruction. With the advance of pregnancy, an

antihemolysin formed in the mother's blood which prevented further blood destruction. If this failed to occur, a progressive anemia would continue during pregnancy. Therefore, it seems one is justified in assuming that there may be a combination of factors directly or indirectly responsible for the anemic condition so frequently encountered.

One of the most interesting facts brought out by the present survey is the return of the maternal blood to its relative normal state within 2 to 6 months after delivery. This certainly denotes that the anemia probably did not exist prior to gestation. One can conceive, however, that a patient who was anemic before and during pregnancy might improve considerably as the result of 12 days' rest in the hospital and careful postnatal management.

Lyon observed a similar anemia in a group of non pregnant women with retroversion, and

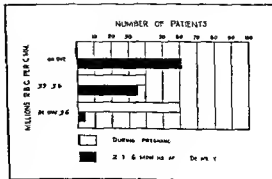


Chart 6 Erythrocyte counts 2 to 6 months after delivery in 100 selected cases



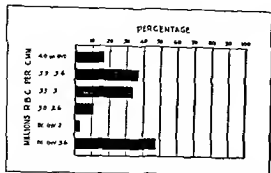


Chart 1 Erythrocyte counts in 1000 pregnant women (all trimesters)

cent of the 106 patients anæmic during pregnancy manifested a pronounced tendency to recover

It is our belief that the loss of blood during labor is primarily responsible for the diminution of red cells after labor. The multiplication of red corpuscles during the puerperium is probably due to the increased activity of the blood forming organs, nature's stimulation of hæmopoiesis to compensate for the primary blood loss in labor.

#### PROGRESS OF ANÆMIA TWO TO SIX MONTHS AFTER DELIVERY

One hundred selected patients with an anemia during pregnancy had another count taken 2 to 6 months after delivery. A comparison of these counts shows that many patients had made remarkable recoveries. Especially is this to be observed in the red cell tabulation (Chart 6) in which it is noted that of 60 patients with a count below 3.6 million

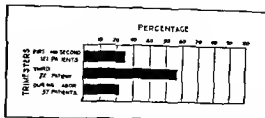


Chart 2 Percentages of counts below 3.6 million per cmm in different trimesters

during gestation, only 4 failed to rise above this level. However, 2 of these 4 patients showed an improvement of over 200,000, the other 2 on examination one year after delivery, had made no improvement. Although no patient in the selected group had a normal count in pregnancy, 61 of them gave counts of 4 million or over, 2 to 6 months after child birth. On final analysis it was found that an increase in the red cell count above 200,000 occurred in 92 patients.

Chart 7 shows that 43 patients (43 per cent) had a relatively normal hæmoglobin estimation (over 80 per cent) within 6 months after delivery, although none of these patients had over 80 per cent hæmoglobin during gestation. Only 18 patients with hæmoglobin below 70 per cent failed to rise above this level. However, of these 18 patients, 13 had actually gained over 10 per cent hæmoglobin, though the final estimation was still 70 per cent or lower.

Finally, it may be stated that 93 per cent of the group of 100 selected patients showed an improvement of at least 10 per cent in the hæmoglobin content.

#### DISCUSSION

In a previously published investigation (4) many factors were studied in order to disclose their possible relation to this blood deficiency. Foci of infection in the teeth, tonsils and urinary tract were believed to exert very little influence on the severity of the anemia. Syphilis and toxæmia were seemingly not prominent etiological factors. The specific cause of the secondary anemia therefore remains unknown.

Numerous theories have been advanced in explanation.

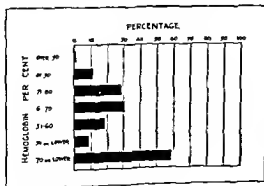


Chart 3 Hemoglobin estimations in 1000 pregnant women

- 17 KIWIACH F A Beitrage zur Geburtshunde Nene Ztschr f Geburtsh 1848, xiv 143-160
- 18 KREINEL POUL Untersuchungen ueber die physiologische Schwangerschafts Anaemie Ztschr f Geburtsh u Gynaek. 1926-1927 xc 511-541
- 19 LYON E C Anemia in late pregnancy J Am M Ass. 1929 xxi 11-14
- 20 MEYER P J Untersuchungen ueber die Veranderungen des Blutes in der Schwangerschaft Arch f Gynaek 1887 xxxi 145
- 21 NISSE H Das Blut Bonn 1836
- 22 Idem. Das Blut der Schwangeren Arch f Gynaek 1876 x 315-355
- 23 PETER M Leçons sur leclampsie puerperale Arch. de tocol. 1875 ii 95-102 215-229 282-292 422-435 540-548
- 24 ROWLAND V C J Am M Ass 1924 xxxi, 372-374
- 25 RUCKER M P A study of the hemoglobin after childbirth with special reference to the resumption of menstruation Am J Obst & Gynec 1921 i 964-972
- 26 SCHROEDER R Untersuchungen ueber die Beschaffenheit des Blutes von Schwangeren und Woechnerinnen so wie ueber die Zusammensetzung des Fruchtwassers und ihre gegenseitigen Beziehungen Arch f Gynaek 1891 xxxix 306-351
- 27 SIEBEN WALTER Ueber das Blut des Weibes in der Geburt und im Wochenbett Beitr z Geburtsh u Gynaek, 1914 xix 236
- 28 THOMPSON W L The blood in pregnancy Johns Hopkins Hosp Bull 1904 xv 205-209
- 29 WILLCOCKS F Some comparative observations on the blood in chlorosis and pregnancy Lancet 1881 ii 944-945

## THE RELATION OF HEPATITIS TO CHRONIC CHOLECYSTITIS

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MANY patients who have been subjected to cholecystectomy for chronic gall bladder disease are not entirely cured of the symptoms which brought them to operation. The residual symptoms cannot be explained completely on the basis of a neurotic constitution, concomitant cardiovascular lesions, or senescence. Clinically it is true that the longer the duration of the disease before operative treatment is instituted, the less the likelihood of cholecystectomy relieving all the symptoms. This is not surprising when it is recalled that (1) anatomical investigations have demonstrated the association of permanent dilatation of the intrahepatic biliary passages with cholecystitis, (2) chronic inflammation of the gall bladder with repeated acute exacerbations may have produced an interference with the normal function of the sphincter of Oddi allowing reflux of bile into the pancreatic ducts leading to a chronic pancreatitis, (3) dense adhesions to, or perforations into, the stomach or duodenum from the gall bladder may interfere permanently with gastric and duodenal motility and thus leave permanent sequelae to the primary lesion. That there may be other reasons for the persistence of symptoms seems likely.

Because of the topographically and functionally close relationship between the liver

and the gall bladder, it was decided to reinvestigate histologically the livers of patients suffering from gall bladder disease.

A series of 27 cases was examined in the following way. Sections of the liver from both the right lobe and the left lobe were taken. In no instance was a section taken at a distance of less than 8 centimeters from the margin of the gall bladder bed. In some of these cases an injection of 5 cubic centimeters of 1 per cent trypan blue solution or 5 cubic centimeters of Higgin's India ink into the left gastro epiploic vein was made prior to the excision. The sections were wedgeshaped and weighed almost 1 gram. The incisions extended at least one centimeter into the liver substance. They were fixed immediately in formaldehyde embedded in paraffin and were examined after they were stained with the usual methods.

### HISTOLOGICAL DESCRIPTION

In 25 of the 27 cases, definite liver changes were found, although in Cases 7, 10, and 15 only one of the two specimens removed from different parts of the liver showed such lesions. In all these cases, there was definite histological evidence of chronic inflammatory change in the gall bladder.

There were only 2 cases in which no changes could be found in the liver. One of these (Case

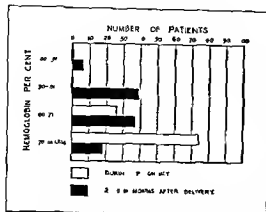


Chart 7 Hemoglobin estimations 2 to 6 months after delivery in 100 selected patients

he, therefore, maintained that the anemia of pregnancy represented a pre existing anemia. The patients, however, who did not manifest any improvement in our series were probably anemic before the advent of pregnancy. Thorough examination of these women may reveal other causative factors.

#### SUMMARY AND CONCLUSIONS

1 Of the one thousand patients examined in various periods of gestation, 47.4 per cent gave evidence of an anemia, with red cell counts of 3.5 million or less.

2 A distinct hæmoglobinæmia of 70 per cent or less occurred in 38.6 per cent of the gravidae.

3 Only 24.7 per cent of the patients examined in the first two trimesters showed a moderate to a severe anemia in contrast to 56.7 per cent of the patients examined in the third trimester. Although the latter group constitutes a much larger number of patients we feel that the anemia is as a rule more marked with the advance of pregnancy. Of a group of 35 patients with a definite anemia in the early months of gestation, 26 showed improvement at term.

4 Of 106 patients with a moderate to a severe anemia, however, 58.4 per cent began to show improvement within 1 to 2 days after childbirth. Of 94 patients with a mild anemia or a normal count during pregnancy, 73.4 per cent showed the effect of labor by a further

reduction of the red cell count within 24 to 48 hours.

5 A marked improvement ensued within 7 to 10 days after labor, occurring in approximately 72.6 per cent of the 106 patients anemic during pregnancy.

6 The most interesting feature disclosed by this study was the remarkable recovery developing within 2 to 6 months after delivery. A distinct improvement in the red cell count took place in 92 per cent of the 100 patients examined. In 95 per cent there was also a marked improvement in the hæmoglobinæmia.

NOTE: The Dare hæmoglobinometer employed in this study was tested and standardized at frequent intervals by Dr. Baxter L. Crawford, pathologist to the Jefferson Medical College Hospital.

#### BIBLIOGRAPHY

- 1 ALDER, ALBERT. Beitrag zur Kenntnis der Anämien in der Schwangerschaft. *Ztschr. f. Geburtsh. u. Gynaek.* 1924 lxxvii 505-518.
- 2 ALLAN, W. Hemolytic anemia in pregnancy. *Surg. Gynec. & Obst.* 1928 xlvii 669-671.
- 3 ANDRAL and GAVARRET. Quoted by M. Peter loc. cit.
- 4 BLAND, P. B. GOLDSTEIN, LEOPOLD and FIRST, ARTHUR. Anemia in pregnancy and in puerperium. *Am. J. M. Sc.* 1930 cxxxix 43-66.
- 5 Idem. The blood platelets in pregnancy and in puerperium. To be published.
- 6 Idem. The blood sedimentation test in pregnancy and in puerperium. *Surg. Gynec. & Obst.* 1930 l 419.
- 7 BLUMENTHAL, R. Ergebnisse der Blutuntersuchung in der Geburtshilfe und Gynaekologie. *Beitr. z. Geburtsh. u. Gynaek.* 1907 vi 414.
- 8 CRANING, W. Notes on anemia principally in its connections with the puerperal state and with functional diseases of the uterus with cases. *New England Quart. J. Med. & Surg.* 1842 i 157-188.
- 9 DUBNER. Untersuchungen ueber den Haemoglobingehalt des Blutes in den letzten Monaten der Gravidität und in Wochenbette. *Muenchen. med. Wchnschr.* 1890 xxvii 517-519, 537-539, 551-553.
- 10 FEHLING. Ueber die Beziehungen zwischen der Beschaffenheit des Blutes bei Schwangeren und der Zusammensetzung des Fruchtwassers. *Arch. f. Gynaek.* 1886 xxviii 454.
- 11 FOCASSIER. De la numération des globules du sang dans les suites de couches physiologiques et dans la lymphangite utérine. *Rev. mens. de méd. et de chir.* 1878 vi 559-560.
- 12 GALLOWAY, C. E. Anemia in pregnancy. *Am. J. Obst. & Gynec.* 1929 xvii 84-89.
- 13 GIVEY, J. C. M. Hematology of pregnancy and the puerperium. *J. Obst. & Gynec.* 1906 ix 261-267.
- 14 GRAM, H. C. Physiological anemia of pregnancy. *Uglen. f. Læger.* 1920 lxxix 1609-1611.
- 15 HOFBAUER, J. F. Ueber die placentare Theorie der Ek-lampæ. *Ätiologie. Zentralbl. f. Gynaek.* 1903 xxxii 1469-1474.
- 16 KERR, W. and COLLINS, L. L. Hemoglobin estimates in pregnancy. *Am. J. M. Sc.* 1926 cxxxix 545-553.

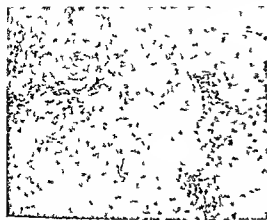


Fig. 1 Section from liver. Periportal infiltration. Multiple small intrahepatic nodules. Low power.

from the bile 2 minutes after injection into the portal vein.

Recent work has also shown that bacteria circulating in the blood stream are ingested first by the Kuepfer cells and many of these bacteria survive the process of phagocytosis and remain viable in the body of the cell for days and weeks. An elimination of these bacteria occurs after any kind of stimulation of the Kuepfer cells when they appear in the bile.

Such observation would point to another very probable source of infection of the gall bladder. That is, through the bile ducts through which the infected liver bile reaches the gall bladder and begins the infection of the latter. The fact that Graham succeeded in demonstrating the same bacterium in cultures from both the liver tissue and from the bile in the gall bladder would be in perfect harmony with such a process. Experimental evidence also points in this direction. It has been shown by Wilkie that cholecystitis can be produced in rabbits by intravenous injection of streptococci. If, however, ligation of the cystic duct precedes the injection of streptococci, no cholecystitis can be observed. It is also of great importance in these experiments that no liver changes occur in the cases in which ligation of the cystic duct seems to prevent the development of cholecystitis. On the other hand, in cases in which cholecystitis does develop the liver changes observed are quite similar to those described by Graham and by us. Wilkie also showed that liver changes

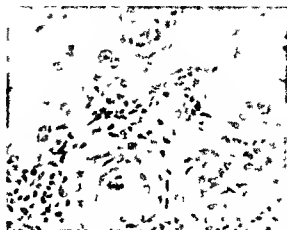


Fig. 2 Section from liver. Small bile duct and vein surrounded by a coat of round cells including a few polymorphonuclear leucocytes.

could be prevented in cases in which cholecystitis was produced experimentally by the intravenous injection of streptococci if the gall bladder had previously been dissected free from its bed so that it hung from its vascular and biliary pedicle and was prevented from readhering to the liver bed by the interposition of omentum.

Graham tries to overcome this apparent incongruity by suggesting the lymphatic path for the spreading of the infection from the liver to the gall bladder. This view has also been supported by Judd.

Graham states that hepatitis begins and is most marked in the periportal tissue. The infection is apparently brought to the liver by the portal vein and more rarely perhaps by the hepatic artery. Pericholangitis then occurs and because of the intimate anastomosis between the lymphatics of the intrahepatic and extrahepatic biliary systems, a direct extension takes place into the wall of the gall bladder. It is perhaps a vicious cycle between the gall bladder and liver whereby each may infect the other. Still, the majority of the cases of cholecystitis, according to him, represents a lymphatic spread from the liver. The minority includes some hematogenous cases, some contact infections from bacteria carried down in the bile and a few cases which may have originated from an ascending infection of the common duct.

17) showed anatomically distinct lipoid infiltration of the gall bladder mucosa (strawberry gall bladder) but no other changes indicating even a moderate degree or a healing stage of cholecystitis. The other case (24) was operated on with the diagnosis of cholecystitis but a peptic ulcer of the pylorus was found and the gall bladder proper did not show inflammatory changes, histologically.

On examining the slides with low power magnification it was easy to ascertain that there were numerous foci of cell infiltration. These foci were observed mainly in the connective tissue about the larger intrabepatic branches of the portal vein. Such infiltration spread eccentrically from one side of the vessel wall toward the periphery and only occasionally surrounded the whole lumen. The infiltration was usually more of a diffuse character and tended to spread over the ramifications of the periportal stroma. Closer examination revealed that the areas most heavily infiltrated were those in which small bile ducts could be seen. Wide lymph vessels were also often observed in some of these areas.

Besides these conspicuous perivascular infiltrations quite a few nodules were scattered throughout the liver tissue which appeared on low power examination as primary intrabepatic foci. Invariably however a bile duct was visible in the center and it was demonstrable that the aggregation of cells took place in the connective tissue which surrounded this bile duct. Smaller branches of the portal vein and lymph vessels could also be seen.

The cells found in both perivascular infiltrations and the scattered nodules were of various types including lymphocytes, a few plasma cells, histocytes, fibroblasts, polynuclear leucocytes and occasionally eosinophiles. The presence of histocytes could be established clearly in those cases which prior to the excision had received an injection of India ink or trypan blue. Storage of the dyes by some of these cells revealed their true nature and determined them as cells of the active mesenchymal type. Polynuclear leucocytes were not found in every case. They were most numerous in Case 2 in which the inflammatory condition of the gall bladder was also of a more subacute type.

Examination of the liver tissue outside of the nodules and perivascular infiltrations showed certain changes of varying intensity. They consisted of the presence of a larger number of Kupffer cells than usual and of the presence of fairly numerous cells in the lumen of the intertrabecular liver capillaries. These cells included polynuclear leucocytes, lymphocytes, and particularly large mononuclear cells, most of which belonged obviously to the group of monocytes. These intracapillary changes were not met with in every case and their intensity was unequal in its distribution over a single slide.

We can summarize these changes as follows. There is an interstitial hepatitis of varying intensity which is localized essentially in the periportal connective tissue. The inflammation is of a chronic character and seems to center about the larger branches of the portal system.

The presence of inflammatory changes in the liver in cases of gall bladder disease has been stressed by Graham (5) in a series of papers in which he tried to show that such changes are practically constantly associated with cholecystitis. Experimental work done by the same author led him to the belief that there was a casual connection between liver and gall bladder changes. Graham (6) recognized two ways of infection. One is the direct hematogenous route whereby bacteria reach the gall bladder wall through the circulation and bacterial emboli in the gall bladder capillaries are responsible for the onset of inflammation. The other way is that of lymphatic spread from the liver through the outer coats and finally to the mucosa of the gall bladder. Graham believes that the latter is the more common and almost regular way in which infectious cholecystitis is brought about.

It has been proved beyond any reasonable doubt that bacteria which circulate in the blood either in case of septicemia or after experimental injection into the blood are rapidly excreted from the liver and pass into the bile as in the process of normal secretion. This has been shown experimentally for typhoid bacilli (Dour and Chiarolanza), bacillus prodigiosus (Fuetterer), and staphylococcus (Biedl and Kraus). Fuetterer was able to recover bacteria

titis and concomitant liver changes. Wilkie's experiments, in which the gall bladder was separated from the liver by the interposition of omentum and in which cholecystitis was produced by the intravenous injection of streptococci but no liver changes developed subsequently, are further substantiation of our objection to Graham's interpretation. Graham himself in a later paper seems to realize the fallacy of his early statements and admits the possibility of liver infection secondary to gall bladder disease. He maintains, however, the conception of a vicious cycle according to which the infection would also spread from the liver to the gall bladder.

If Graham's point of view were correct we should find severe inflammatory changes of the gall bladder in all cases of severe hepatitis. This is not borne out by actual clinical and postmortem experience.

Our histological findings corroborate those of Graham, but the arguments presented induce us to take a contrary view of the pathogenesis of the hepatic lesion. We maintain that the gall bladder lesion is prior to the development of inflammatory changes in the liver. The mechanism of the production of gall bladder infection still remains a question. It is most probable that gall bladder infection is brought about by bacteria laden bile. It seems also logical to assume that in most or perhaps in all, cases the bile contamination results from bacteria which have passed through the capillary filter of the liver without the production of noteworthy local changes. The infection once developed in the gall bladder spreads to the liver through some of the lymphatics of the gall bladder which drain into the liver. The products of such gall bladder infections bacterial or otherwise once in the liver are carried through the larger lymphatics to the periportal tissue and are responsible for the changes described in this paper.

This conception of secondary involvement of the liver in primary gall bladder disease can be reconciled to the clinical observation that patients with long standing gall bladder disease are less frequently and completely relieved of their symptoms by cholecystectomy than are those in whom the disease has been of shorter duration. It also suggests another reason for the plea for earlier surgical treatment in gall bladder disease.

#### SUMMARY AND CONCLUSIONS

- 1 Changes in the liver coincident to cholecystitis are described
- 2 These lesions are interpreted as chronic hepatitis predominating in the periportal tissue
- 3 The relationship of the liver lesion to chronic gall bladder disease is discussed
- 4 Evidence is presented to demonstrate that the liver changes are secondary to gall bladder inflammation

We desire to express our thanks to the members of the Staff of the Crown Heights Hospital whose co operation made it possible to secure the clinical material for study.

#### REFERENCES

- 1 BIEDL and KRAUS: Ueber die Ausscheidung der Mikroorganismen durch druesige Organe. *Ztschr f Hyg u Infektionskrankh* 189, xxvi 353
- 2 CHIAROLANZA: Experimentelle Untersuchungen etc. *Ztschr f Hyg u Infektionskrankh* 1909 lxii 22
- 3 DOERR: Experimentelle Untersuchungen etc. *Centralbl f Bakteriologie* 1905 xxix 622
- 4 FUETTERER: Wie bald gelangen etc. *Berl klin Wchnschr* 1899 xxxvi 58
- 5 GRAHAM E A: Hepatitis a constant accompaniment of cholecystitis. *Surg Gynec & Obst* 1918 xxvi 521
- 6 Idem: Further observations on the lymphatic origin of cholecystitis. *Arch Surg* 1922 iv 23
- 7 HARER W B, HARGIS E H and VAN NETER A C: Function of gall bladder. *Surg Gynec & Obst* 1922 xxxiv 307
- 8 JUDS E S: Relation of liver and pancreas to infection of gall bladder. *J Am Med Ass* 1922 lxxvii 197
- 9 ROLS and McMASTER: *Proc Soc Exper Biol & Med* 1920 xii 215
- 10 WILKIE A L: Significance of hepatitis in relation to cholecystitis. *Brit J Surg* 1928 xvi 214



Fig 3 Section from liver Intrahepatic nodules surrounding small bile ducts Small lymph vessel in the center

Our histological findings confirm those of Graham. This is of considerable importance since in our cases the sections were taken at so great a distance from the gall bladder bed that it would be impossible to ascribe the changes to the spreading of the inflammation by direct extension. Similar lesions were found in sections taken from the left lobe of the liver on the other side of the falciform ligament, through which some of the lymphatics of the liver drain.

This seems to establish the constant association of interstitial hepatitis with cholecystitis. The explanation of the pathogenesis of the liver lesion as described by Graham does not seem warranted. Description of the lymphatics of the gall bladder and of the liver and the consideration of the functional value of both organs would make it difficult to accept lymphatic drainage from the liver to the gall bladder. That the drainage normally goes the other way seems more likely from the work of Rous and McMaster showing the absorption of water from the gall bladder in the process of concentrating bile. Harer, Hargis and Van Meter introduced a hypertonic solution of potassium sulphocyanide into the gall bladder lumen and then collected lymph from the subserous lymphatics by cannalization with capillary tubes. The lymph so obtained gave a Prussian blue reaction with ferric chloride.

Primary hepatic inflammation by hematogenous infection does not localize in the peri-

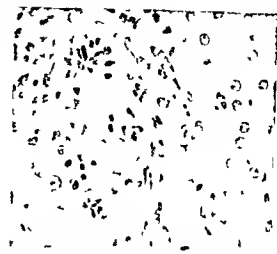


Fig 4 Section from liver Small nodule eccentrically adjoining a bile duct Storage of fine India ink granules in the histocytes

portal connective tissue and is at variance with the picture which we have described. Bacteria circulating in the blood in case of septicæmia or after experimental injection are taken up by the phagocytic cell of the liver sinuses. The reaction to the presence of bacteria in these sinuses is manifested by exudation and proliferation at those points with extension into the adjacent liver tissue. The periportal tissue may participate in this process later on, but the changes here if they do occur do not appear as the outstanding features of the inflammatory reaction. This type of lesion presents a great contrast to the histological picture obtained in an ascending biliary infection in which the lesion is predominantly periportal.

The two arguments presented would indicate that exception must be taken to two basic contentions in Graham's paper. His theory assumes primary infection of the liver and spreading of the inflammatory process to the gall bladder through the lymphatics. These concepts are not tenable in view of the anatomical, physiological and pathological evidence just presented. Further support of our position against that of Graham is furnished by the experimental work of Wilkie, who demonstrated the significance of descending contact infection in the pathogenesis of cholecys-

We have observed 23 cases of this localized type of chronic ulcerative colitis, in 15 of which the patients were first seen in 1928 and in the first half of 1929. In only 1 case had the diagnosis been made before the patient came to the clinic. This led us to report this series of cases. There seems to be little doubt that other similar cases have passed through our hands unrecognized. In the 23 cases, surgical exploration was carried out in 11 and the suspected disease was confirmed. The condition most frequently confused with, or suspected in, these cases was tuberculosis. Surgical intervention seemed wise in several cases to determine whether or not tuberculosis was present and in 3 further verification was obtained by necropsy.

The clinical story in most of these cases aroused suspicion, but in none was it entirely diagnostic. The salient features included in intermittent attacks of diarrhoea, or of frequent rectal discharges, usually mixed with much pus and streaked with blood. At times a severe haemorrhage was the first indication of trouble. Pain was a prominent feature in all but one case, usually it was cramp like and was felt along the line of, or in some portion of, the colon. At times it came in attacks lasting a few days, with twinges of pain off and on and then there was complete freedom for a few days, resembling in some instances the colic like pain of cholecystic disease.

The diarrhoea or frequency of rectal discharges was rarely as great as in the usual severe case of chronic ulcerative colitis, but it was more frequently associated with grueling cramps. Fever of low grade was usual and loss of weight was rather striking; one patient lost 50 pounds in 4 months.

Data obtained by roentgenograms of the colon, after barium enema, are given in the tabulation.

#### SUMMARY OF HISTORIES OF ELEVEN ILLUSTRATIVE CASES

**CASE 1.** A merchant, aged 50 years, came to the clinic August 25, 1928, with a history of occasional rectal bleeding of 4 or 5 years duration. The blood had been mixed with the stools and the stools had been streaked with blood. The day before admission he had suffered a severe rectal haemorrhage with collapse which had subsided with rest and sedatives.



Fig. 1. Case 1. Spastic deformity involving the transverse colon.

so that by August 29 we felt safe in making roentgenological examination of the colon after injection of barium. The roentgenoscopic examination disclosed the entire transverse colon involved in an extensive spastic deformity with considerable irregularity of the contours of the lumen. Proximal to the hepatic flexure and distal to the splenic flexure the colon was normal (Fig. 1). Proctoscopic examination did not give evidence of chronic ulcerative colitis.

**CASE 2.** A plumber aged 48 years, came to the clinic August 5, 1929 with a history of having had diarrhoea since 1904. Meanwhile he had felt run down. He had been having a slight elevation of temperature, frequent night sweats and weakness. The diarrhoea had consisted of about eight rectal discharges every 24 hours. A diagnosis of pulmonary tuberculosis had been made, although no abnormalities had been noted in the thorax and he had been confined in a sanitarium for tuberculosis for 4 months. Examinations of sputum and stool had failed to reveal acid fast bacilli. During his care in sanitarium his fever had subsided and his general condition had improved but the condition of the bowel had remained the same. In addition to the continued diarrhoea there had been attacks of bleeding, distress in the epigastrium and at times pain in the region of the umbilicus which sometimes had required hypodermic injections and which sometimes had been relieved by vomiting. Proctoscopic examination August 9 disclosed a normal



REGIONAL MIGRATORY CHRONIC ULCERATIVE COLITIS<sup>1</sup>

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THE designation "chronic ulcerative colitis" suggests to clinicians of any considerable gastro-intestinal practice a serious infectious disease. That the name is inadequate is generally agreed. "Colitis" is a loose term which in the minds of many includes intestinal conditions, both organic and functional without the necessary presence of inflammation of the colon. This should not be so. "Chronic ulcerative" might easily be taken to refer to other than one type of inflammation. The German term "colitis gravis" connotes its seriousness. It does not convey the idea of its suppurative nature. The two words "ulcerative" and "colitis" seem well chosen. In addition there should be a modifying term to designate etiology. "Bacterial" may not be specific enough but will serve to distinguish the condition from the parasitic, tuberculous, chemical or toxic ulcerations of the colon.

The clinical signs and symptoms of chronic bacterial ulcerative colitis include a history of frequent rectal discharges of blood, pus, and mucus, mixed with feces of variable consistency, depending in a large measure on the extent to which the colon is involved. The ulceration usually begins in the rectum and spreads upward eventually to involve the entire colon. It may, however, affect any part of the colon and occasionally several parts of the colon. Early in the course of the disease or at a time when the rectum and rectosigmoid portion of the colon only are affected the stools may be scabious and surrounded by or mixed with blood, also there will be frequent passages of shreds of bloody pus and mucus, with great desire to strain, and occasionally with griping pain and tenesmus. When all or most of the colon is involved the stools are liquid or mushy and mixed with mucus, blood, and pus. Gruelling cramps are not uncommon. Distress from gas, griping

and various sensations along the course of the colon are often experienced. A peculiar gray pallor is common, and varying degrees of anemia exist. In the severer cases a morbid body odor prevails. An anxious, rather hopeless facial expression is not uncommon. The patient's lack of control of the bowel, with the feeling that he must remain near a lavatory, may account for some of this. Much weight may be lost.

A septic type of fever occurs in the severe fulminating cases, although slight elevation of temperature is common in chronic cases. Mild leucocytosis, with polymorphonuclear leucocytes predominating is the rule. Depleting chronic invalidism occurs rather early in the disease. There is a form of this disease hitherto not well understood namely cases in which the mucosa in the view of the proctoscope and sigmoidoscope, is normal.

The literature is lacking in descriptions of an ulcerative condition of the colon of the type of chronic ulcerative colitis in the absence of proctoscopic evidence. At The Mayo Clinic, in recent years cases have come to our attention in which there was no proctoscopic evidence of chronic ulcerative colitis yet the patients presented themselves with symptoms similar to those described in the preceding paragraphs and they were found to have extensive involvement of other parts of the colon.

Previously we have stressed the great importance of the barium enema in the diagnosis of chronic ulcerative colitis. In the group of cases here described the roentgenogram is the sole method of gaining a clue to the diagnosis other than clinical assumption.

In some instances surgical exploration has become necessary to confirm the diagnosis or else because of obstruction or other complication operation has afforded opportunity to establish the diagnosis.

We have observed 23 cases of this localized type of chronic ulcerative colitis, in 15 of which the patients were first seen in 1928 and in the first half of 1929. In only 1 case had the diagnosis been made before the patient came to the clinic. This led us to report this series of cases. There seems to be little doubt that other similar cases have passed through our hands unrecognized. In the 23 cases surgical exploration was carried out in 11 and the suspected disease was confirmed. The condition most frequently confused with, or suspected in, these cases was tuberculosis. Surgical intervention seemed wise in several cases to determine whether or not tuberculosis was present, and in 3 further verification was obtained by necropsy.

The clinical story in most of these cases aroused suspicion, but in none was it entirely diagnostic. The salient features included in intermittent attacks of diarrhoea, or of frequent rectal discharges usually mixed with much pus and streaked with blood. At times a severe haemorrhage was the first indication of trouble. Pain was a prominent feature in all but one case, usually it was cramp like and was felt along the line of, or in some portion of the colon. At times it came in attacks lasting a few days, with twinges of pain off and on and then there was complete freedom for a few days, resembling in some instances the colic like pain of cholecystic disease.

The diarrhoea or frequency of rectal discharges was rarely as great as in the usual severe case of chronic ulcerative colitis, but it was more frequently associated with grueling cramps. Fever of low grade was usual and loss of weight was rather striking, one patient lost 50 pounds in 4 months.

Data obtained by roentgenograms of the colon, after barium enema, are given in the tabulation.

#### SUMMARY OF HISTORIES OF ELEVEN ILLUSTRATIVE CASES

**CASE 1.** A merchant aged 50 years came to the clinic August 25, 1928 with a history of occasional rectal bleeding of 4 or 5 years duration. The blood had been mixed with the stools and the stools had been streaked with blood. The day before admission he had suffered a severe rectal hemorrhage with collapse which had subsided with rest and sedatives



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Fig 3 Case 3 The localized narrowing just distal to the site of ileocolostomy resembles the constriction in Figure 2

tory of having had loose stools for  $2\frac{1}{2}$  years, a condition which had become progressively worse until in 24 hours he had been passing between 25 and 30 watery stools mixed with mucus and blood. On admission he was having between 8 and 12 such discharges. Exploration September 24, 1934 gave evidence of chronic ulcerative colitis of the transverse colon for which a permanent ileostomy opening of the modified Brown type was done. Considerable improvement in the patient's general condition followed. March 18, 1935 plastic repair of a malfunctioning ileostomy opening was made and a postoperative ventral hernia was repaired. Death occurred 9 days later from generalized peritonitis.

CASE 6 A married woman aged 26 years who came to the clinic June 16, 1938 had begun to have trouble with her bowels following a severe attack of influenza 3 years previously. At no time since had she had more than 5 or less than 3 loose stools in 24 hours. There had been very little mucus and blood had not been observed, however the patient used an outside toilet and mucus or blood might not have been observed. Proctoscopic examination showed normal rectal and sigmoidal mucosa and roentgenologic examination disclosed extensive narrowing and loss of haustra of the hepatic flexure and entire transverse colon. In Figure 5 besides abrupt narrowing and destruction of normal contour inadequate filling due to the marked hyperirritability is



Fig 4 Case 3 There is marked improvement in the deformity. The roentgenogram was made 4 weeks after that shown in Figure 3

shown. Figure 6 shows a large portion of the small intestine filled with opaque medium, but the uppermost transverse segment is the transverse colon after the condition has improved. The roentgenogram was made 5 weeks after that shown in Figure 5. Concentration of the medium and apparent widening of the involved segment are shown.

CASE 7 A married woman aged 35 years came to the clinic in August, 1925 with a history of gnawing epigastric pain of 4 years' duration. The pain had come on in attacks lasting 3 or 4 weeks at a time with free intervals of 6 to 8 weeks. Food or soda had not given relief. Nausea and vomiting occasionally had been associated with the pain. For this reason appendectomy and abdominal exploration had been done in October, 1924 at which time disease of the stomach had not been found. There had been no history of diarrhea but there had been intermittent loose stools with alternate periods of constipation. Roentgenograms of the thorax, gall bladder and stomach gave negative results at this time. Roentgenologic examination October 3, 1925 showed little narrowing but marked absence of haustra and some firmness of the marginal contours of the transverse and ascending colon. Exploration October 12, 1925 resulted in a diagnosis of chronic ulcerative colitis of the ascending and transverse colon. Treatment consisted of a vaccine prepared from the diplococcus of chronic ulcerative colitis obtained from other patients with chronic ulcerative colitis. Subsequent examination revealed



Fig 2 Case 2 Diffuse narrowing of the ascending colon with marked annular deformity of the proximal part of the transverse colon

rectal mucosa for 4 cm. Roentgenologic observation after barium enema revealed abrupt narrowing over a short segment of the transverse colon near the hepatic flexure. Attention is called in Figure 2 to the marked irregularity in the contour of the involved portion due to the deep ulceration. This filling defect might easily be confused with that resulting from an annular carcinoma except for its great length. There were no clinical signs of pulmonary disease and roentgenogram of the thorax gave negative results.

**CASE 3.** A manager of a Canadian packing firm aged 49 years came to the clinic July 4, 1929 with a history of difficulty with the bowels dating back to 1913 at which time a diagnosis of ulceration of the colon had been made and treatment with silver nitrate, ichthyol and glycothymolin had been instituted and clinical cure accomplished. In 1911 he had had a recurrence of the same or similar trouble. In the course of these attacks he had had four to six rectal discharges with urgency and the passage of blood and pus. Treatment similar to that given before had resulted in relief from symptoms. January 1, 1926 he had felt a certain uneasiness in the right side of the abdomen and examination had revealed tenderness and a mass. This had resulted in operation for drainage of an abscess in the right side of the abdomen which had been followed by a fecal fistula. Four months later resection of the right half of the colon with closure of the fecal

fistula had been done and after a stormy convalescence the patient had seemed free of symptoms until January 1929 when he had begun to notice blood in the stools with frequency so that he had had to get up several times at night to move his bowels. This had continued with aggravation and partial remission until his admission to the clinic at which time he was having six to seven rectal discharges with blood and pus in 24 hours. The proctoscopic examination at this time showed evidence of old chronic ulcerative colitis and multiple small polyps. Roentgenoscopic examination of the colon exhibited a freely emptying enterocolostomy opening near the hepatic flexure and just distal to its point of attachment a short narrowed segment of transverse colon of rough contour similar in all respects to that shown in Figure 2. In Figure 3 the inadequate filling of the involved segment is contrasted with the good concentration of opaque medium in Figure 4 after a short period of treatment.

**CASE 4.** A railroad switchman aged 42 years came to the clinic May 7, 1928 stating that his trouble had begun rather suddenly with diarrhea in March 1927 and that it had continued for 6 months with a movement of the bowel every 2 to 3 hours. The stools had been watery with small amounts of mucus and considerable blood. The patient had been hospitalized for 4 weeks during May and June and the diarrhea had subsided. On leaving the hospital he had been very weak and did not return to work until the following October. The movements of the bowels had been regular until early in March 1928 when he had found great difficulty in moving them. He spoke of the condition as progressively increasing constipation with soreness in the left lower quadrant of the abdomen and blood in the stools. At this time in the general examination it was noted that the descending colon was palpable and cordlike. After 6 months the trouble subsided. At the time of examination at the clinic proctoscopic examination did not show evidence of chronic ulcerative colitis but the mucosa just above the anus anteriorly was thrown into indurated folds as of an old rectal abscess. Roentgenologic examination revealed extensive spastic deformity of the distal segment of the transverse colon and proximal two thirds of the descending colon. In several short segments there was abrupt narrowing with considerable destruction of mucosa. The colon both proximal and distal to the involved portion was normal.

**CASE 5.** A barber aged 38 years came to the clinic in September 1924 at which time the roentgenologic investigation showed an extensive irregular partly spastic filling defect involving the hepatic flexure and proximal third of the transverse colon. A similar deformity of the rectum was present and was assumed to be another probably the primary focus. A diagnosis of ulcerative rectal stricture with incontinent anal sphincter and a filling defect in the transverse colon was made. The patient had a his



Fig 7 Case 10. There is one deformity at the hepatic flexure and another in the sigmoid. The former is healing; the latter shows evidence of active chronic ulcerative colitis.



Fig 8 Case 11. There is diffuse narrowing of the cecum and proximal part of the ascending colon with mucosal destruction.

in the bowel probably the sanguinopurulent discharge from the lesion which was subsequently found although there was a suggestion of a lesion in the descending colon near the splenic flexure. Proctoscopic examination April 24 showed that the sigmoidal mucosa bled more easily than normal. Otherwise there were no rectal pathological lesions. Because of the patient's age and the history of bleeding exploration was advised. April 30 exploration revealed chronic ulcerative colitis from the middle of the transverse colon to the middle of the sigmoid flexure of the colon with the most intense disease in the splenic flexure. Under treatment with serum the patient was relieved of symptoms.

CASE 10. A woman aged 29 years came to the clinic August 1, 1929. She had had much trouble with abscesses and infections for 11 years. These had included an appendiceal abscess in 1918, cholecystitis in 1921, and streptococcal peritonitis in 1926 for all of which operations had been undertaken elsewhere. In November 1918 the patient had begun to pass blood and mucus in the stools with considerable cramping pains. Colonic irrigations with solution of potassium permanganate were undertaken without bringing relief. On admission to the clinic the complaint was of partial intermittent intestinal obstruction with cramp-like pain in the right side and middle of the abdomen associated with periods of distention and bloating. Inability to

move the bowels and between such attacks, the passage of blood, pus and mucus in the stools. Proctoscopic examination showed that the mucosa was normal for 24 centimeters. Roentgenologic examination exhibited abrupt narrowing in the proximal half of the sigmoid colon with marked irregularity of the contour of the involved portion. The lesion resembled closely those observed in Cases 2, 3, 5 and 6. There was also a marked organic stricture in the distal limb of the hepatic flexure (Fig 7). Exploration September 6 disclosed two regions of chronic ulcerative colitis, one in the sigmoid colon and one in the transverse colon, near the hepatic flexure, the latter of which had caused a stricture. Caecostigmoidostomy was done, serum was administered and marked clinical improvement resulted.

CASE 11. A woman aged 31 years came to the clinic October 13, 1925. She had had diarrhea with the passage of 20 to 24 loose green stools in 24 hours without noticeable blood. She had also had numerous painful sores in her mouth on her lips and tongue. On admission her weight was 78 pounds and she had a temperature of 100.6 degrees F. Roentgenoscopic investigation disclosed considerable narrowing with evidence of mucosal destruction in the cecum and proximal part of the ascending colon. There was some evidence of marked irritability of the terminal portion of the



Fig 5 Case 6 The transverse colon is extensively involved and the deformity is typical of chronic ulcerative colitis. Disease is not evident elsewhere in the colon.



Fig 6 Case 6 The arrows point to the involved segment of the transverse colon shown in Figure 5. Marked improvement has taken place after specific treatment.

the colon after some treatment had been given. Slight irregularity of the margins remained but the involved portion was more pliable and showed some return of haustral markings.

**CASE 8** A printer aged 41 years came to the clinic April 8, 1949. He had been well up to 4 years before his coming to the clinic at which time he had begun to have generalized cramping abdominal pains associated with mucus in the stools and relieved by movements of the bowels and the passage of gas. After 3 months of this he had begun to have diarrhea with 6 to 9 stools in 24 hours mixed with blood mucus and much flatus. This had continued for about 2½ years and had resulted to a diagnosis of chronic ulcerative colitis being made elsewhere. The only improvement had been for several weeks in the latter part of November 1927 the trouble soon had recurred. Roentgenologic investigation done elsewhere at this time had revealed a narrowed descending colon of smooth contour without haustra apparently hyperirritable and unable to maintain a normal concentration of opaque medium. At the time of admission to the clinic he was having about 6 rectal discharges every 24 hours mixed with blood mucus and pus. Proctoscopic examination at this time showed a normal rectal mucosa except that on the edges of the second and third valves there were some ulcers. At roentgenologic investigation the involvement of the sigmoid and descending portions

of the colon were not as extensive nor as severe as on previous investigation. But an area in the splenic flexure about 20 centimeters in length was found to be narrowed, smooth and hyperirritable and a roentgenologic diagnosis of localized chronic ulcerative colitis was made. After specific treatment had been given roentgenologic investigation showed that haustra had returned and that irritability was absent. A smooth sigmoid colon was the only residuum of the infection. The roentgenogram of the thorax at this time did not reveal abnormality. Treatment consisted of specific serum later of vaccine and examination in September 1929 showed clinical cure and that the patient was free of symptoms. Proctoscopic examination September 13 showed a bowel with normal mucosa for 25 centimeters. The roentgenogram did not give evidence of the defects which had formerly been noted.

**CASE 9** A rancher aged 61 years came to the clinic April 13, 1949. He had suffered from so called gastritis for 15 or 20 years and from diarrhea for 7 months with 10 to 12 stools daily and loss in weight of 50 pounds. There had been much rumbling and gurgling in the intestines. The diarrhea was in the form of discharges containing considerable blood and mucus. Considerable difficulty in cleansing the bowel was encountered and the roentgenogram was unsatisfactory on account of the constant presence of a large amount of fluid material

toms referable to the disease in the colon varied from 4 months to 13 years, all but 6 having had symptoms for more than 2 years.

In 11 of the cases, the sigmoidoscopic examination did not give evidence of disease, in 6 others, there was no evidence of disease in the rectum but high in the sigmoid colon were irregular ulcers, or the mucosa of the sigmoid colon bled more easily than normal or, as in 2 cases, sigmoid polyps were seen on an inflammatory base. In 2 cases, irregular ulcers were noted in the rectum, in 2 typical lesions of chronic ulcerative colitis and in 2 evidence of healed lesions of the disease. In 11 of the cases there were complications of the chronic ulcerative colitis in 4 strictures of the colon, in 3, polyps in 1 case, arthritis, and in 3 cases fistula about the rectum.

Our treatment, after the diagnosis was established, included, primarily, specific serum and vaccine. Eighteen of the 23 patients received either the concentrated fasting serum or vaccine prepared from the diplococcus of chronic ulcerative colitis, or both. Four had to undergo ileocolostomy because of stricture, 1 submitted to ileostomy because of the extent and progression of the disease, caecostomy was done in 1 case because of the situation of the obstruction at the hepatic flexure and in the sigmoid, in another case ileostomy was performed later colectomy was done because of hemorrhage, and later still ileosigmoidostomy.

Fifteen of the 23 patients are clinically cured. Three others are doing well but it is too early to speak of them as cured. Five have died: 1 patient from the subsequent development of carcinoma of the stomach, 1 from subsequent carcinoma of the ovary, 2 patients from extension of the disease into the small intestine after ileosigmoidostomy, and 1 patient from peritonitis after ileostomy.

Opportunity has not so far been afforded for a second roentgenologic examination in many of these cases. In 3, however, later roentgenograms showed complete disappearance of the defects.

The roentgenologic evidence of chronic ulcerative colitis is constant and characteristic although the stage, severity and extent of the process, and the degree of destruction of

the mucosa and thickening of the wall which has taken place may produce a limited variation in the picture. In a typical case, the disease progresses orad from the rectum, the seat of its inception, and proctoscopic examination reveals a typical appearance. When the disease is confined to the rectum, the roentgenologist may fail to detect significant changes, but when it has progressed to the more proximal segments, he points to the syndrome of narrowing and shortening, marked hyperirritability, loss of haustration, and signs of destruction of the mucosa as pathognomonic. The occurrence of chronic ulcerative colitis in one or more isolated segments of the colon with negative results in the rectum, is significant, although relatively rare, and although the appearance of the diseased portion is identical with the appearance of the colon that is affected typically with the disease, yet the atypical distribution frequently will give rise to confusion. The involvement may be gross and extensive, or the disease may be confined to a segment which is so short, and the narrowing may be so abrupt, that a filling defect characteristic of malignant disease is closely simulated. The diseased portion is subject to the same complications as is the colon in the ordinary case of chronic ulcerative colitis, namely, secondary infection, perforation, polyposis, stricture, and malignant change. Tuberculous colitis and amebic colitis, which commonly begin in the proximal segments of the colon are the other ulcerative lesions of the colon which have a roentgenologic appearance similar to that of this type of chronic ulcerative colitis. Although typical cases of each present such characteristic data that misinterpretations are easily avoided mistakes will happen so frequently that the establishment of the correct final diagnosis will demand the closest co-operation of roentgenologist and clinician.

When one considers carefully the history of these cases, the changing and irregular proctoscopic picture, the variety of situation of the disease in the colon as revealed by the roentgen ray, and the subsequent disappearance of the lesions, one is confronted with two major questions: (1) whether chronic ulcerative colitis is blood borne, and (2) whether the



TABULATION—SUMMARY OF DATA

Case	Situation and extent of lesion as revealed by roentgen ray	Item at per cent	Length in m	Inches	Stool	
					Result of culture	Result of examination for parasites
1	Entire transverse colon	60	3.7	5.700	Not cultured	
2	Proximal transverse and ascending colon and cecum	57	4.5	7.000	Not cultured	Negative
3	Proximal third of transverse colon descending colon and sigmoid	57	3.75	10.700	Diplococcus	Negative
4	Middle and distal portion of transverse colon and proximal portion of descending colon	80	4.61	6.800	Not cultured	Negative
5	Two defects in descending colon near hepatic flexure and cecum	60	3.80	6.600	Not cultured	E. lamblia type
6	Transverse and descending colon	50	3.8	11.700	Diplococcus	Chlamydia m. stools
7	Ascending and transverse colon	74	4.46	9.100	Not cultured	Lamblia in stools
8	35 cm. at splenic flexure and descending colon	67	4.3	8.800	Diplococcus	3 stools negative
9	Middle of transverse colon to middle of ascending colon	80	5.03	11.000	Diplococcus	Negative
10	Transverse colon near hepatic flexure (8 cm.) and sigmoid (10 cm.)	47	3.35	10.000	Diplococcus	Negative
11	Ascending colon	50	3.19	8.700	Diplococcus	3 stools negative
12	Entire transverse colon and descending colon	51	4.36	8.800	Not cultured	3 stools negative
13	Cecum and ascending colon	61	4.10	11.800	Not cultured	Not examined
14	Ascending colon, descending colon, sigmoid, transverse colon, hepatic flexure	50	3.70	9.000 10.300	Diplococcus Chlamydia m. stools	3 stools negative
15	Middle of transverse colon lesion 12 g. by 3 cm.	76	4.5	11.9	Diplococcus by proctoscope	Negative
16	Transverse colon with ring of terminal polypoid perforation	49	4.31	6.700	Diplococcus	8 stools, 1 negative, 7 rectal smears negative
17	Distal portion of transverse and proximal portion of descending colon narrowing of distal portion of descending colon	61	4.34	11.300	Diplococcus	Chlamydia m. h.
18	Left half of colon	65	3.95	9.90	Negative	Negative
19	Left half of colon	70	4.54	7.90	Not cultured	3 stools negative
20	Entire colon	3	3.41	7.30	Diplococcus	Negative
21	Entire colon	70		11.90	Diplococcus	Negative
22	Proximal portion of descending colon and splenic flexure	63	4.07	7.90	Not cultured	Negative
23	Ascending and transverse colon and proximal portion of descending colon	60	4.51	7.0	Not cultured	Negative

ileum (Fig 8) Under symptomatic treatment and specific vaccine she made rapid progressive improvement so that she was dismissed 2 months later and returned to the clinic in March 1918 at which time she reported that she had gained 25 pounds in weight and had had normal formed stools for several months.

In the cases reported, the diagnosis before admission to the clinic had included amebic dysentery in 2, tuberculosis of the intestine in 5, cholecystitis in 2, malignant disease of the colon in 2, fistula in 2, dysentery in several and adhesions or no diagnosis in the others. Previous treatment had included colonic irrigations, care in a sanitarium for tuberculosis

injections of emetin, appendectomy, tonsillectomy, hemorrhoidectomy, hysterectomy, and other abdominal operations as well as medication by mouth.

Of the 23 patients, 15 were males and 8 were females. They came from ten states of the United States and two provinces of Canada: 7 from Illinois, 4 from Iowa, 2 from Indiana, 2 from Alabama, 1 from Kansas, 1 from Montana, 1 from New York, 1 from Nebraska, 1 from Texas, 1 from Minnesota, 1 from Manitoba, and 1 from Ontario.

The length of time before the patients came to the clinic over which they had had symp-

dealing with various phases, from case reports to classification of the organism and treatment.

One of the most interesting features has been that, until recently, the majority of the cases have occurred in Chicago and the immediate vicinity. The reason for this is not quite clear although it may have been due to the fact that the profession there has been more on the alert for the disease or that the disease is to some extent endemic in that vicinity. Due to its marked similarity clinically and pathologically to tuberculosis, many cases doubtless pass unrecognized, so that it seems quite probable that the disease is more prevalent than is generally supposed. The increasing number of reported cases from widely scattered sections of the country lends credence to the belief that the disease is fairly common, and that increasingly accurate and scientific diagnostic methods are responsible for its detection.

#### ETIOLOGY

As to the organism responsible for this disease, there exists much dispute regarding classification, division into strains, and cultural characteristics. Gilchrist's original work still holds today, a proof of its high quality, and all are agreed that the organism, as described by him is a yeast double contoured, with granular cytoplasm, reproducing in the tissues only by budding, but beyond this there is very little unanimity of opinion. Terminology, classification, cultural characteristics, and closely allied strains are subjects of debate.

The earliest disputes arose over the question of terminology and classification. In his original article Gilchrist described the case as "A Case of Blastomycetic Dermatitis." In Bussé's report, which appeared after Gilchrist's verbal communication of 1894 but before his article in 1896, the organism was given the name "*saccharomyces hominis*." Later disputes over classification and terminology have had for their basis minor cultural differences, with the result that numerous investigators have attempted to divide the whole group into subdivisions representing closely allied strains. One can read equally

authoritative communications on the subject and obtain diametrically opposed facts and opinions regarding cultural characteristics and classification. Although at first glance it seems irreconcilable, such discrepancies in no way mitigate against the value and reliability of the individual work. In the final analysis the macroscopic appearance of the cultures, the presence or absence in them of mycelia or aerial hyphae seem to depend on whether the cultures have been kept moist or dry, at incubator or room temperature and whether or not it is the first culture or the sixth or seventh subculture. Furthermore in many instances, after periods of artificial cultivation many strains reproduced by endosporeulation.

Recently Castellani claimed that there is a plurality of species and succeeded in isolating three types. Suggesting the term "*blastomycoides*" for the group he designates the three types as "*blastomycoides immittis* (Rixford and Gilchrist, 1897), *blastomycoides dermatitidis* (Gilchrist and Stokes, 1898), *blastomycoides tulaneensis* (Castellani, 1926)." Culturally, on artificial media, these organisms all grow mycelia with no sugar fermentation. In the body lesions, they are all round or oval, budding, double contoured with granular protoplasm and no mycelia. Michelson concluded that the reaction of the tissues in systemic blastomycosis is an allergic one, and that unfavorable conditions cause the organism to revert to the oidial or yeast stage. The yeast like growth is the resistant form, the aerial growth the saprophytic form.

In any event, from the standpoint of one who has had no experience in culturing the organism but has given considerable study to the conflicting views of authorities on the subject it seems justifiable to assume that we are dealing with a disease entity caused by a yeast like fungus. The organism is round or oval, varying in size from 5 to 30 micra, with an outer refractile capsule, a somewhat granular cytoplasm. It reproduces in the tissues by budding only, and grows readily on all ordinary media.

Predisposing factors in the matter of infection are quite evident in most of the reported cases. Most patients have lived in unhygienic surroundings, and infection has taken

disease starts in the rectum, and the organisms then migrate to other more favorable parts of the colon, or whether the disease affects the large parts of the colon, the rectum heals, and parts elsewhere fail to keep pace in healing. These problems undoubtedly bear on the problem of the portal of entry of the infection.

#### CONCLUSIONS

1 Regional, segmental localized or migratory ulcerative colitis is a form of chronic

ulcerative colitis which is more difficult to recognize than the usual form of chronic ulcerative colitis which begins in the rectum.

2 It presents a diagnostic problem for on its correct diagnosis depends the prognosis; needless operation and long care in sanitarium may be avoided. Specific treatment should be instituted as soon as the diagnosis is established.

## LOCALIZED INFECTION CAUSED BY YEAST-LIKE FUNGI

### WITH SPECIAL REFERENCE TO THE SPINAL INVOLVEMENT

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**I**N view of the fact that biologists are far from unanimous in regard to the classification of various fungi, medical literature on this subject is a most confusing labyrinth. This is particularly true in the case of the disease known as 'blastomycosis'. Numerous attempts to simplify nomenclature and classification of the causative organism in this disease have resulted in its being described under several names. Since the majority of cases reported in this country have been reported as blastomycosis the disease will be referred to under this name in the present discussion. In general it may be stated that the term 'blastomycosis' is used to designate a disease systemic or local caused by a yeast like organism which reproduces in the tissues by budding only. It is characterized by chronic inflammation, ulceration and abscess formation with marked debilitation.

#### HISTORY

The condition was first recognized as a distinct disease entity and the causative organism discovered by Gilchrist and was described by him before a meeting of the American Dermatological Society in 1894. It was subsequently reported by him in his excellent article, in 1896. Doubtless due to the fact that this case was clinically one of cutaneous lesions, succeeding reports and

descriptions of the disease were of a similar nature. Montgomery and Ricketts reported three similar cases in 1901 and a few months later Hyde and Ricketts abstracted all similar cases reported up to that time (17 in all) adding 3 of their own. The following year Walker and Montgomery reported the first case of cutaneous blastomycosis becoming systemic, claiming that previously reported cases of systemic blastomycosis had been primarily systemic with cutaneous lesions. In 1903, Eisendrath and Ormsby reported a systemic case beginning supposedly in the lungs and included in their report abstracts of 4 previously reported systemic cases, those of Busse and Buschke, Walker and Montgomery, Ormsby and Miller and Cleary. They claimed that their case was the fifth reported case of systemic blastomycosis. Bassoe's case reported in 1906, was the first one in which vertebral involvement was noted. Hektoen in 1907 reported 13 cases systemic and cutaneous, considering very thoroughly blastomycosis and coccidiosis (coccidioidal granuloma). Since his report most comprehensive articles have appeared from time to time such as those by Montgomery and Ormsby, Stober and Wade and Bel until at the present time the disease has become fairly well known. Within the past 10 years the literature contains some 100 to 150 articles on the subject.



Fig 3 High power field showing a budding form of the blastomycetes



Fig 4 Roentgenogram of cervical spine showing erosion of articulating facets between the seventh cervical and first thoracic and destruction of the transverse process of the seventh cervical. Note lateral buckling of cervical spine

culosis in that there is less central necrosis and sharper differentiation at the periphery of the lesion. The organism can usually be demonstrated in the tissues a single giant cell at times containing several. For details of the pathological findings the reader is referred to the descriptions of Hektoen, Montgomery and Ormsby, Stober and Wade and Bel, which are most complete.

In regard to the method of dissemination, once the organism has gained entrance to the body, there seems to be little doubt but that the organism at times circulates in the blood stream from which it can often be cultured. In this respect the disease differs somewhat from coccidioidal granuloma which shows a marked predilection for the lymphatics. It therefore follows that in the course of systemic blastomycosis, depending on the duration of the disease, all the viscera have been known to be involved. However, some organs are rarely involved, examples being the heart and thyroid. In 1904 Cleary reported a case in which he found the organism in the myocardium microscopically, although there were no gross pathological lesions demonstrable. Michelson's case showed similar lesions. The only other case with myocardial involvement is that of Hurley, in which numerous blas-

tomycotic abscesses were found in the heart muscle. The only reported case of thyroid involvement is that of Michelson. In general, the relative frequency of involvement of the various organs in systemic blastomycosis depends on the usual factors involved in any such disease, namely, virulence of the organism, resistance of the patient, and the duration of the infection.

#### CLINICAL ASPECTS

The details of the clinical pictures of the systemic and cutaneous forms of the disease are well known, and it is unnecessary to dwell upon them here. The articles referred to above contain excellent descriptions of the clinical side of the disease in all its forms, together with the differential diagnosis. The chronicity of the disease leading to extreme states of debility and emaciation, with pulmonary, genito-urinary, neurological, or skeletal symptoms superimposed, have been ably presented and further repetition would be superfluous.

On the other hand, cases of purely localized blastomycosis seem to warrant some consideration, inasmuch as general systemic involvement can be prevented and a cure can be



Fig 1 Roentgenogram of the chest showing the abscess encroaching on the apex of the left lung

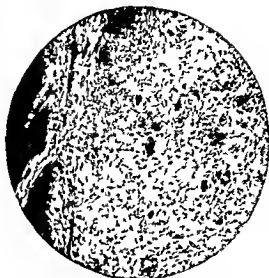


Fig 2 Low power field showing general tissue reaction and presence of giant cells. Note blastomycetes

place in the months when dampness and mold growth prevail. In fact Stober investigated the living quarters of some of his patients and found that practically all lived in damp houses often in the presence of decaying wood etc. He scraped samples of mold from the floor boards in some of the dwellings and in some cases cultured a mold very similar to that recovered from the patient.

As to the mode of infection or the portal of entry in most cases there is not much question. In the cutaneous forms of the disease it is probably due to direct contamination of a wound or abrasion. Many of the systemic cases on the basis of history alone lead one to believe that the upper respiratory tract is the main portal of entry. One case has been reported in which it seems quite probable that the gastro intestinal tract served as the point of entrance of the infection, the site being the stomach where a blastomycotic ulcer was found (Sihler). Although cutaneous lesions coincident with systemic infection are common, very few systemic cases can be traced to pre existing cutaneous forms of the

disease. Stober claims that this was true in only one of the cases appearing in his report. Nevertheless there are many cases as will be noted later in which no portal of entry can be determined with any degree of accuracy and these are the types with which the present communication is primarily concerned.

There is no evidence of contact infection no case having been reported in which anyone caring for a patient with the disease has become affected. On the other hand some care must be used in handling the organism in view of Stober's experience in which the breaking of a culture tube in the laboratory was followed by severe pharyngitis and laryngitis within a few hours in one worker while the other developed a chill with fever and purulent bronchitis within 6 hours.

#### PATHOLOGY

Pathologically the disease closely resembles tuberculosis the two being practically indistinguishable in some cases. Grossly the essential pathological picture is that of a chronic granulomatous lesion. Microscopically it closely resembles tuberculosis showing marked round cell infiltration with numerous somewhat atypical giant cells of the Langerhans type. It differs from tuber-

tract were negative except for slight evidence of an ulcerative colitis. Stereoroentgenograms of the cervical spine showed erosion of the transverse process of the seventh cervical vertebra with slight erosion of the articulating facets of the seventh cervical and first thoracic vertebrae on the left (Fig. 4). A large (soft part) shadow extending downward into the posterior mediastinum and encroaching very slightly on the apex of the left lung could be seen (Fig. 1). Roentgenograms of the chest showed the lungs to be clear.

A tentative diagnosis of a destructive process involving the seventh cervical and first thoracic vertebrae probably tuberculosis was made. Due to the fact that the lesion as seen in the X-ray film was atypical in many respects and that there was much doubt as to the correctness of the diagnosis of tuberculosis, an exploratory operation was performed on May 7, 1936, 10 days after admission to secure tissue for pathological examination. At this time, an extrapleural abscess containing about 10 cubic centimeters of pus was found running parallel to the second rib. Attempts to remove tissue from the interior of the abscess were unsuccessful. However, the pus was evacuated and the wound closed without drainage, the character of the pus seeming to confirm the diagnosis of tuberculosis. Head traction was applied immediately.

Briefly, the postoperative course was steadily downhill. Pain increased in severity until finally it could no longer be controlled by narcotics. The temperature showed a daily rise to 39 degrees C. By repeated roentgenograms it was seen that the process in the spine was progressing rapidly; the abscess shadow enlarging. The first thoracic vertebra began to show bone destruction. About 20 days after operation the patient developed persistent cough with expectoration of large quantities of thick pus. Signs of pneumonia developed on the left and the patient's condition became critical. On June 4, 4 weeks after operation, the incision broke down after which each inspiration was accompanied by a loud hissing sound as air was aspirated through the wound. The guinea pig inoculated on May 7 with the pus obtained at operation was autopsied on June 4 and no tuberculosis was found. Reports on the direct cultures of the same pus had been negative. On the evening of June 5, the patient's temperature rose to 42 degrees C, respirations and heart action became weaker until finally the patient died at 9:30 p.m.

An autopsy was performed immediately with the following findings. At the base of the neck, on the left several centimeters above the clavicle is a wound from which there has been free drainage. It is seen on dissection that a sinus tract leads down to a very irregular ramifying cavity with greenish colored necrotic walls. It is filled with very foul smelling grayish green semifluid material. The muscles are necrotic in many places. The large nerves arising at the base of the neck have suffered quite severely, and many large nerve tracts have been eroded

through and the ends lie dangling free in the abscess cavity. The first three ribs, together with the abscess cavity, the three lower cervical and two upper thoracic vertebrae are removed intact. The abscess cavity is seen to extend downward anteriorly to the level of the third or fourth thoracic vertebra. It is immediately adjacent to the aorta and the esophagus neither of which seem to be affected. Laterally the abscess cavity extends toward the apices of the lungs. On the left it has pushed before it the apex of the lung for a distance of 2 to 3 centimeters; the lung here is covered with a thick, tough fibrinous membrane which is layered over with grayish green necrotic exudate. It is impossible to express air from the lung into the cavity. Section of this lung with dissection of the bronchi fails to reveal any abnormality other than some congestion of the mucous membrane. No fistula was found. The lung tissue itself does not seem to be greatly affected. Despite the close proximity of the abscess wall the tissue seems to be everywhere air containing. In the lower portion of the left lung are found widely scattered elevated areas of consolidation about 6 centimeters in diameter. They are quite opaque and suggest small areas of tuberculous pneumonia. No tubercles can be found in any portion of either lung. The right lung is relatively normal throughout. The heart shows a very slight amount of scarring of the aortic valves but otherwise no abnormalities are found. The spleen is somewhat enlarged. On section the malpighian bodies are somewhat enlarged and irregular in size and shape. The stomach, duodenum and pancreas appear normal. The capsule of the liver is quite thickened and grayish opaque in color. The lobulation is rather coarse. The structures at the hilus appear normal. The adrenals appear normal. The kidneys present a somewhat granular appearance on stripping the capsule but on section they seem normal. The pelvic organs are normal. In the sigmoid about 4 to 5 centimeters above the anal orifice and extending upward about 10 centimeters is an area of rather extensive inflammation. There is a large amount of congestion and some hemorrhage below the mucosa. Over the surface is a grayish opaque fibrinous membrane. There is no true ulceration and the rest of the intestinal tract is negative. The spine is dissected free and split lengthwise. There is very extensive erosion of the outer portion anteriorly from the level of about the sixth thoracic. The first thoracic is the site of very extensive alteration. The bone destruction is extreme; the body of the vertebra has collapsed and the two vertebral discs are very close together. There are a number of areas of yellowish softening in the inner portion of the second and third thoracic vertebrae and in places these extend inward to the vertebral canal lifting up the dura, but there is no evidence that the process extends inward toward the pia arachnoid. The aorta and other large vessels show a moderate amount of atheroma. The brain is not removed.

effected if proper treatment is instituted. The success of the treatment is dependent on an exact and timely diagnosis. As was intimated above, lesions have been described in practically all parts of the body in the course of systemic infection. But the localized infection is rare, and brings up many interesting questions regarding the mode of infection, difficulty of diagnosis, prevention of dissemination of the disease, and treatment. The recognition of these localized lesions as blastomycosis would doubtless decrease the incidence of the systemic disease with its coincident high mortality.

The following case is reported as an example of a localized blastomycotic infection to emphasize the great difficulties encountered in making a diagnosis. Literally forced to a diagnosis of tuberculosis in the face of negative laboratory findings, although rebelling against it because of the extremely atypical clinical course, we made the true diagnosis of blastomycosis only after postmortem examination. Even so it was only after repeated sections had been cut and carefully studied by the pathologists that the organisms were discovered. They too were at first forced to consider the case as one of tuberculosis because of the lack of any other distinguishing findings, and their careful search over a long period was prompted only by the fact that the lesions were not typical of tuberculosis.

Case No. 796. A G. male Italian aged 29 years a casket maker was admitted to the Strong Memorial Hospital April 27, 1926 complaining of cramp like pain in the epigastrium of one week's duration. There were no other gastro-intestinal symptoms except for occasional attacks of diarrhea of short duration for one year preceding admission to the hospital. During this year patient had been unable to work because of bone and muscle pains and weakness in the left arm. These pains in the arm had increased in severity up to the time of admission. In addition the patient had experienced some vague generalized muscle pains but these were not severe. The weakness in the left arm had progressed rapidly from the time of onset until the time of admission, but he had experienced no muscular weakness in any other part of the body. The patient stated that he had lost considerable weight during the present illness. The patient's past history was essentially negative. He had come to this country 6 years before admission having lived all his life in Italy. His general health had always been excellent with no

serious illnesses. He had served in the Italian Army during the World War and had been wounded in the right arm. Tonsillectomy had been performed 1½ years before admission. The family history was entirely negative.

Physical examination revealed a well developed but considerably emaciated young Italian appearing very ill weighing 166 pounds (average weight 195 pounds). There was no general glandular enlargement but the epitrochlear were palpable. All the special senses were normal. There was a very slight diffuse enlargement of the thyroid but no evidence of increased activity or toxicity. The lungs were clear to auscultation and percussion. The heart was normal in all respects except for some tachycardia explainable on the basis of an increase in temperature which was 39 degrees C. The blood pressure was 125-80 and pulses were regular in force and rhythm. Abdominal examination failed to reveal any abnormality other than tenderness in the right lower quadrant without spasm or rigidity. Examination of the genitalia and rectum was negative. The deep reflexes were all present but thought to be slightly hyperactive.

The main interest and findings in the examination were found in the left hand and arm where atrophy of the muscles about the thumb and the intrinsic muscles of the hand attracted immediate attention. Fibrillary twitchings of the muscles of the hand were prominent. By actual measurement it was found that the left wrist was 3 centimeters smaller than the right, some difference in size between the two arms being evident all the way to the shoulder. There was marked muscular weakness in the left hand and arm especially in those muscles supplied the sixth and seventh cervical segments through the median nerve and eighth cervical and first thoracic through the ulnar. Sensory changes coinciding with the cutaneous distribution of sixth seventh and eighth cervical and first thoracic were also marked. The reflexes were all present but slightly hyperactive. The right arm was normal.

Examination of the back showed a definite atrophy of the shoulder girdle on the left especially the infraspinatus and supraspinatus muscles. There was marked prominence over the lower cervical and upper thoracic spine with pressure tenderness over the sixth and seventh cervical and first second and third thoracic vertebrae. All motions of the head and neck were painful and there was spontaneous pain over the left side of the neck and left shoulder. Except for these findings general neurological examination was negative. Examination of the blood showed the white blood cells to be 11,200 with 72 per cent hemoglobin. The differential count showed 74 per cent polymorphonuclears and 26 per cent lymphocytes. The blood and spinal fluid Wassermann examinations were negative. The spinal fluid was negative throughout. The urine had a specific gravity of 1.014, no albumin or sugar, no Bence Jones bodies and microscopically it was negative. X-ray studies of the gastro-intestinal

Parker's case was similar to these cases clinically but, unfortunately, the organism was not cultured nor was it discovered in microscopic sections, which somewhat weakens the case as one of blastomycosis.

There is a striking similarity in these 3 cases. All were young men, two being foreigners who had lived in this country only a short time. Pain in the back over the affected vertebrae was a constant feature and pain in the epigastrium was a symptom of all. This epigastric pain was doubtless reflex in origin due to compression of the spinal roots. In all 3 cases a clinical diagnosis of tuberculosis was made. Aspiration of the fluctuating mass in the case of Brewer and Wood, disclosing the presence of blastomycetes, gave the correct diagnosis and determined the type of treatment to be followed. The negative cultures and guinea pig inoculations in the 2 other cases prevented a correct clinical diagnosis.

In the face of negative cultures and inoculations, the only other diagnostic aid which can lead to a differential diagnosis of the bone lesions is the X ray. By those who have studied the X ray changes seen in blastomycosis the lesions are considered quite typical. Closely resembling tuberculosis in many instances, there is usually something atypical. In the present case, the involvement of the articulating facets with lateral curvature of the spine can be taken as an example. In Parker's case, the vertebral involvement spreading to the laminae transverse and spinous processes finally to include the rib is a picture which, as he points out, is practically unknown in tuberculosis.

A detailed description of the X ray findings in osseous blastomycosis is included in Stober's article. The essential features are that there is localized rarefaction, more patchy than in tuberculosis, accompanied by bone proliferation and bony periostitis. The epiphysis remains normal unless the joint is involved. Sequestered bone is not observed and the bone immediately surrounding the lesion is normal. Single or multiple lesions are frequently seen in the long bones.

#### CASES OF LOCALIZED INFECTION

No case of localized blastomycosis of the eye has been recorded. Apparently the cornea

and conjunctiva are particularly resistant to the infection, although, according to McKee, it is occasionally seen. In a review of the subject, he found only 3 cases of keratitis from which the blastomycetes were isolated. He reported a case of corneal ulcer from which he had obtained the organism. All these infections occurred in the course of systemic disease. In view of the frequency of the cutaneous forms of the disease especially about the face it seems rather remarkable that the eyes escape involvement.

Localized infection of the tongue has been observed by New of the Mayo Clinic, in a man 52 years of age. Except for the local condition in the mouth his general physical examination was negative. The diagnosis was made by biopsy, and a cure was effected by potassium iodide internally, iodine and radium locally. The correctness of the diagnosis in this case was doubted by Weiss, who pointed out that the lymphoid hyperplasia shown in the photomicrographs was not typical of the disease. He claimed that the illustration designated as 'pure culture of blastomycetes' might be the picture of any yeast as there were no distinguishing features shown. He concluded his criticism by saying that the fact that the lesion healed under potassium iodide and radium was no proof that it was blastomycosis. Besides this one case Copelli reported an undoubted case. Although there was no demonstrable systemic involvement in his case the patient had blastomycotic lesions on both feet.

In a case reported by Vinson, Broders and Montgomery the oesophagus was the site of the disease. The patient was a man of 41 years of age with a tuberculous history. The sputum was positive for tubercle bacilli at the time of admission to the clinic. Roentgenograms of the chest showed active pulmonary tuberculosis. His symptoms of oesophageal obstruction were confirmed by X ray and oesophagoscopy. A biopsy of the mass obstructing the oesophagus showed it to be blastomycosis. The sputum was negative for blastomycetes. There was some improvement in the patient's condition under treatment consisting of iodides by mouth, gentian violet intravenously, and oesophageal



*Microscopic notes* An old thickened pleura presents near the outer surface some fresh pleurisy undergoing organization. The gray areas of consolidation in the lungs are found to be areas of early gangrene. There is some organizing pneumonia and a little fresh pneumonia in the neighboring alveoli. There is no evidence of tuberculosis. Spleen pancreas kidneys and liver appear normal. Sections of the intestine show a rather intense inflammation in the mucosa but very little otherwise. The sinus shows an extensive inflammatory reaction. There is fibrosis and degeneration of muscle fibers. Nothing suggesting tuberculosis is seen. Sections of bone show partial replacement of the marrow with fibrous tissue and some wandering cells. In places there are many giant cells but all are more the type seen in foreign body reactions than in tuberculosis. Many of these giant cells contain round spore like bodies with refractile capsules (Figs 2 and 3). These spores vary from 8 to 14 microns in diameter. Each contains some granular material which nearly fills the space within the outer shell. It is interesting that the walls of the abscess cavity show no such organisms. No similar organisms can be found in any other sections.

*Anatomical diagnosis* Yeast infection of the cervical vertebra with the formation of an abscess in the neck. Lobular pneumonia with early gangrene. Diphtheritic colitis.

A consideration of this case brings up the question as to the portal of entry of the organism. There were no cutaneous lesions and the lungs were negative clinically and by X ray examination, nor were there any suspicious respiratory symptoms to render such clinical findings questionable. The X ray shadow at the left apex was obviously due to a mass outside the thorax encroaching on the lung field. The pulmonary involvement found at postmortem examination was undoubtedly secondary to the spinal lesion. No other blastomycetic lesion was found so we are forced to admit that the portal of entry in this case is undetermined.

The difficulties of diagnosis are well illustrated. Clinically the case was peculiar and the initial diagnosis of tuberculosis became less probable as one followed the patient's progressive downhill course. The severity of the patient's illness and his rapidly progressive failure contradicted the diagnosis of tuberculosis. On the other hand the negative culture of the pus obtained at operation supported it, until a few weeks later it was found that the inoculated guinea pig failed to show any evidence of tuberculosis. In addition the

spinal lesion as seen in the X ray picture (Fig 4) was not typical of tuberculosis. The result was that no definite diagnosis could be made with the evidence at hand.

The case seems quite simple when viewed in the light of the later postmortem findings. However, the clinicians were not the only ones experiencing difficulty in diagnosing the case. Due to the fact that the organisms were not numerous, it required long careful study and many sections finally to establish the diagnosis. This doubtless also accounts for our negative cultures and animal inoculations.

#### SPINAL BLASTOMYCOSIS

The first case of blastomycosis which showed spinal involvement was reported by Bassoe in 1906. The spinal involvement in his case was metastatic in the course of systemic infection. The second case reported was that of Eisendrath and Ormsby, the preliminary report of which appeared in 1903, followed in 1907 by the final report. Stober in his series of 29 cases found spinal involvement in 20 per cent.

The present case is the third case on record in which blastomycosis of the spine existed as a primary or localized lesion. The other cases are those of Brewer and Wood and Parker. The former was quite similar to the present case. The patient was a Russian, aged 20 years, who had been in this country only 6 months. He complained of pain in the abdomen in addition to pain in the back. Except for the local condition of swelling and tenderness over the lumbar spine, physical examination was negative. The lungs were clear. Sputum and stool cultures were negative. The diagnosis was made only after aspiration of the abscess and blastomycetes were found in the pus. At operation the spinous processes and laminae of three dorsal vertebrae which were found to be involved were removed together with all involved soft parts. The patient improved and was discharged only to return 2 months later with other vertebrae involved (first second and third lumbar). A similar operation was performed at this time with excellent results. The patient was last seen one year after operation at which time he was perfectly well.

view, while Stoddard and Cutler claim that the latter explanation is probably more correct.

The symptoms in these cases are those of unlocalized brain tumor or meningitis, the latter being due to secondary meningeal irritation. These cases invariably end fatally. Careful postmortem examination has failed to reveal any portal of entry or systemic disease in many of the reported cases.

There has been considerable dispute over the disease as it is encountered in the central nervous system. The cases mentioned and referred to in the present communication have appeared in the literature under the heading blastomycosis, except those of Stoddard and Cutler. It is quite apparent that the cases described in the literature are similar to those they describe as being due to torula infection. In fact they state that the brain involvement consisting of multiple gelatinous cysts is peculiar to torula infection alone.

Isolated cases of non systemic blastomycosis occurring in unusual sites have occasionally appeared in the literature. Hicks reported a case of a paronychia from which yeast cells were isolated. He classified the organism under the blastomyces. Weidman and Douglas described a tumor of the leg, clinically resembling sarcoma which proved to be blastomycosis. One instance of infection of an operative wound with blastomyces has been reported (9). The mother and brother of the patient had cutaneous blastomycosis, but the patient had previously shown no evidence of the disease. A case, probably not blastomycosis but of sufficient interest to warrant mention, was reported by Rhoney. Following the ingestion of yeast cakes over a period of 2 years, the patient developed a severe cystitis. Urinary smears and culture showed no ordinary bacteria but budding yeast cells. Marked improvement with the disappearance of the organisms was obtained under treatment consisting of iodides and salicylates by mouth. Preis and Forro reported a case of urethritis under the name of blastomycosis. The patient was under treatment for lues and diabetes when he developed an acute urethritis from which a

pure culture of "saccharomyces" was obtained.

It is quite evident that localized blastomycotic lesions can occur in various parts of the body. In many instances the portal of entrance of the organism seems obvious while in others it is obscure. Doubtless many such infections, escaping early recognition, serve as the starting point of general systemic disease.

#### DIFFERENTIAL DIAGNOSIS

Blastomycosis is probably much more common than is generally supposed, many cases undoubtedly receiving the diagnosis of tuberculosis. The marked resemblance of the two clinically is so close as to be indistinguishable. In the absence of postmortem and pathological examination, it is obvious that many cases of blastomycosis are overlooked. The resemblance is present in all forms of the disease. There is one outstanding difference between the two, response to treatment. Except for the central nervous system where both diseases are uniformly fatal, tuberculosis usually shows some response to general hygienic care whereas blastomycosis never does. Despite the best upbuilding measures, blastomycosis continues to advance, a point which should be remembered when any case of "tuberculosis" does not respond satisfactorily to treatment.

Other diseases from which it must be distinguished systemically and locally are coccidioid granuloma and syphilis. The former is a very closely allied disease identical clinically except that it is more malignant, and more rapidly and always fatal. It has never been known to occur in anyone who has not been in the San Joaquin Valley in California. The only distinguishing characteristic is that the organism of coccidioid granuloma reproduces in the tissues by endosporulation whereas the blastomyces reproduces in the tissue only by budding. Except for this one point there are no distinguishing pathological characteristics except that microscopically coccidioid lesions present sharper differentiation at the periphery. From the standpoint of treatment and differentiation this is not so important as the same therapy is indicated in both diseases.

dilatation At the time of the report the patient was still under treatment

Five cases of primary localized blastomycosis of the larynx appear in the literature The first was that of Downing following which Sartory, Petges, and Claoue Jackson, and New reported cases All of these cases were similar clinically As in blastomycosis elsewhere, the close resemblance to tuberculosis was a confusing factor Biopsy of the tissue in each case made the diagnosis Only one case became systemic and ended fatally the others remaining localized and responding well to treatment of potassium iodide One of the patients had remained well for a period of 9 years It is interesting to note that in those cases in which obstructive symptoms necessitated a tracheotomy, the skin surrounding the tracheotomy opening soon became involved

Meningitis due to the blastomycetes occurs in only 12 per cent of the systemic cases according to Stober As a primary form of the disease, it is infrequent Rusk reported the first case in 1910 following which reports by Swift and Bull Barlow, and Wilhelmj appeared, making a total of 7 cases in all The diagnosis of primary meningitis was confirmed by postmortem examination in all but two of these cases no other blastomycetic lesions being found The two unautopsied cases were carefully examined clinically with negative results, so there is no reason to doubt that the infection was localized in the meninges These cases all presented the classical signs and symptoms of meningitis except that in most instances they lacked the acuteness seen in the usual forms of meningitis The majority showed blastomycetes in the spinal fluid In 3 of these cases there is some evidence to support the view that the upper respiratory tract served as the portal of entry In one case (Barlow) the pharynx was covered by an exudate in which blastomycetes were found In another (Barlow) the onset of the illness was with a coryza of 2 weeks' duration Some anosmia, pain and deafness in the right ear were noted The onset in the third case (13) was with a coryza of 2½ months' duration followed by otitis media A persistence of drainage and symptoms

prompted a mastoidectomy, at which only a small drop of pus was found Shortly thereafter postmortem examination showed a meningitis which proved to be blastomycetic in origin An excellent detailed discussion of this form of the disease is given by Wilhelmj who feels that it differs from the other forms of blastomycosis only in that the meninges are invaded early, with death occurring before systemic involvement takes place

Not only is the brain substance itself involved in the course of systemic infection (23 to 30 per cent of the cases) but localized brain involvement without any other demonstrable disease occurs not uncommonly Disregarding the differences of opinion in regard to minor cultural characteristics and terminology, we find that yeast infection of the central nervous system proper occurs in two forms localized abscesses and cystic degeneration of the gray matter The former occurs almost always in the course of systemic infection being metastatic in the course of a general blood stream infection or secondary to localized abscesses of the skull In Moore's case brain abscesses developed following the extraction of what appeared to be a perfectly normal wisdom tooth Abscesses of the face and orbit followed ultimately resulting in death from central nervous system involvement

In the cystic form of the disease as it attacks the central nervous system the portal of entry of the organism is not so obvious In addition the exact classification of the organism or organisms is considerably disputed Pathologically all reported cases seem to be quite similar There is a hyperplasia of the meninges with the formation of phagocytic giant cells with little or no reaction in the neuroglia or connective tissue elements of the cerebral gray matter The latter is the site of multiple cysts varying in size (many are discernible only with the microscope) Whether these cysts are formed by internal expansion and evagination around the infecting organism or by lysis of the surrounding brain substance by some toxic substance derived from the organism is a matter of dispute Freeman and Weidman who reported the twelfth such case in 1923, favor the former

In the treatment of the local lesions there are differences of opinion. Formerly copper sulphate was used, to be replaced later by the application of tincture of iodine. Desjardins advocates X-ray therapy combined with diathermy. He feels that there is no difference in the results obtained if the treatment is given in one fourth skin doses every week or a full skin dose every 3 weeks. Filtration should be gauged by the thickness of the lesion although he states that usually no filtration is necessary. He strongly recommends that diathermy be used in connection with the X-ray as the results seem to be much better than when X-ray alone is used. Application of radium in preference to X-ray has been used by some. Hedge claims that the results obtained by treatment with iodides by mouth, combined with X-ray, cautery or radium have been disappointing in his hands and claims considerable success by the local application of carbon dioxide snow. He has developed a particular technique of application which he describes in detail. If we consider some of the results obtained by the combination of good surgical measures (complete excision) and iodides, before the use of X-ray and radium became so universal we see that the results compare favorably with the latter.

#### PROGNOSIS

Experience has shown that in cases of localized blastomycosis, general systemic treatment combined with good surgery locally (excision) X-ray or radium can accomplish a cure, provided treatment is not started too late in the course of the disease. Once the disease becomes systemic, however all treatment fails in most cases. Temporary improvement with periods of remission seems to be directly attributable to therapy in many instances but recurrences are common some times months and years after an apparent cure. How much can be accomplished by intravenous therapy and the possible development of sera depends on future work. Stober has placed the mortality for systemic cases at 90 per cent. From a consideration of the reported cases it seems that this figure, high as it is, is still a little low. On the other hand good treatment which consists of some form of

the therapy mentioned above, plus persistence, careful "follow up" with a renewal of treatment in case of a suspected recurrence, usually will bring about cure if the condition is localized.

#### SUMMARY

A case of primary or localized blastomycosis of the spine is here described, representing the third such case reported in medical literature. The diagnostic difficulties and problems of therapy are emphasized. A review of the literature of reported cases of other types of localized infection with the blastomycetes is presented.

This study seems to reveal the following: The human body is subject to infection by yeast like fungi to which the body is not particularly resistant, and for which there exists practically no natural immunity. Early in its course the disease is invariably local, rapidly becoming systemic. The portals of entry (suspected) are exposed surfaces, the skin and mucous membranes, whether in the respiratory tract (nose, throat, larynx, trachea etc.) or the gastrointestinal tract (mouth, tongue, oesophagus, stomach). In view of the frequent history of the cutaneous form of the disease following contamination of skin abrasions, it seems probable that some such mechanism explains mucous membrane involvement. The insidious chronic course of the local lesions allows dissemination with subsequent systemic involvement, often before producing noticeable symptoms. Once generalized the prognosis is very poor despite the best treatment. Localized lesions although obstinate, can be cured by potassium iodide internally combined with either radical surgery, X-ray, radium or diathermy locally. The usual treatment for tuberculosis, with which this disease is most often confused, in no way influences blastomycosis. In fact, in many instances this form of treatment allows the disease to progress to a point where the best of treatment is of no avail. All suspected, but atypical, cases of tuberculosis should be scrutinized carefully to rule out blastomycosis.

#### BIBLIOGRAPHY

1. BARLOW. *Med J Australia* 1923 ii 302
2. BASSOE. *J Infect Dis* 1906 iii 91

As in every other disease, syphilis must be ruled out. Here the difficulties are not so great. The local lesions of the two diseases vary considerably. The Wassermann reaction if negative, aids in eliminating lues.

The cutaneous lesions of blastomycosis must be differentiated from epithelioma as well as syphilis and tuberculosis. This applies to the disease as it affects the tongue, larynx and œsophagus. Microscopic examination of the pus which can be expressed from the honeycombed pockets at the edge of the lesions usually will disclose the blastomycetes. If the organisms are not found, a biopsy of the lesion should rule out a new growth.

The final diagnosis of blastomycosis rests on the discovery of the organism. The simplest procedure is to find it in smears from the local lesions or in sections of tissue removed. As a rule it is readily obtained from the skin lesions. In the case of localized abscesses it is often more difficult to find the organism. Since the organism grows well on all ordinary media, failure to find it in smears of pus is not serious. However, it should be borne in mind that the abundant spreading growth seen on the media may very well be mistaken for a contamination, and the culture discarded. In all obscure cases resembling blastomycosis such 'contamination' cultures should be examined carefully to avoid this error.

In addition to obtaining the organisms locally, they can frequently be cultured from the blood stream and urine in the systemic disease, from the cerebral spinal fluid when the central nervous system is involved and from the sputum in pulmonary involvement.

Conflicting views are given by authorities regarding the susceptibility of laboratory animals especially guinea pigs, to infection. Guinea pigs are most often used for animal inoculation since a search is being made for tubercle bacilli. The reason for the discrepancies is probably to be found in the work of Davis. He discovered that while male pigs are particularly susceptible, usually succumbing to the infection, female pigs resist the disease and usually survive, their recovery being characterized by a low grade immunity. In the inoculation of pigs no special selection of male pigs has been made.

#### TREATMENT

It is quite apparent that localized blastomycotic lesions readily give rise to systemic infection. It therefore follows that the earlier the diagnosis and treatment the better the prognosis. There is abundant evidence to show that localized blastomycosis responds well to proper treatment and can be cured. The treatment may be divided into general systemic therapy and local measures. All agree that all patients whether the condition is local or systemic, should be treated by iodides by mouth. The iodides are usually administered as potassium iodide in solution in amounts varying from 10 to 200 minims per day. This treatment has proved its value in most cases. Recently the question of intravenous therapy has received considerable attention. Sanderson and Smith carried out a series of experiments in which they studied the effect of gentian violet on cultures of blastomycetes. They found that gentian violet in a 1:500,000 dilution prevented the growth of cultures. They suggest the intravenous injection of gentian violet in doses of 0.005 grams per kilogram of body weight in systemic cases. In Brazil where the disease seems to be quite common Pupo used local applications and intravenous injections of methylene blue and acriflavine in some cases. In others he used alternate intravenous injections of 10 cubic centimeters of a 1 per cent methylene blue and 5 cubic centimeters of 0.5 per cent solution of trypanflavine. He claimed considerable success with both methods. However the intravenous therapy has not established itself on the basis of its achievements and it is not justifiable to use it as a substitute for the older treatment of iodides by mouth. As an adjunct to the latter treatment in resistant and progressing cases it should be tried in view of the seriousness of the disease. Lately experimental work has been done (6) which shows that passive immunity with the development of a precipitin in the serum can be produced in laboratory animals by the injection of extracts of the blastomycetes. The work as yet has not been carried far enough to be of any therapeutic value although future work may accomplish considerable in this direction.

## THE CULTURE OF TUBERCLE BACILLI FROM THE URINE

## A REPORT OF ONE THOUSAND TWO HUNDRED CULTURES

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IN the presence of tuberculous disease of the kidney and generally speaking of the remainder of the genito urinary tract, it is the surgeon's task to decide which organ is discharging the organisms and to remove the diseased organ from the body, provided conditions permit. The kidney is a vital organ which plays an important role in the clinical pathology of tuberculosis, because failure to diagnose the disease at an early stage and to remove the kidney before the disease is far advanced may carry with it serious consequences for the patient. Our modern technical methods, however, make early diagnosis possible in many cases. Bilateral renal tuberculosis can no longer be considered a frequent disease. Its early recognition is made possible by the use of ureteral catheterization and the bacteriological examination of the urine obtained separately from each kidney.

For a long time the direct growth of tubercle bacilli by artificial culture upon various media has been considered very uncertain and troublesome if not almost impossible. With the development of modern bacteriology it has been possible to perfect such culture media as have proved satisfactory for this purpose. The Koch bacilli are very sensitive in cultures and the development of the colonies requires a much longer time than do those of the staphylococcus streptococcus bacillus coli, and other groups. Furthermore these last mentioned organisms are not so sensitive toward contamination as are the tubercle bacilli.

The method used in the clinic of Professor von Hlyes for the culture of tubercle bacilli from the urine is the method of Loewenstein-Sumiyoshi upon the culture medium of Lubeau modified by Hohn. This procedure has been tested in a series of 300 cases of urogenital tuberculosis and has proved itself not only more convenient but more accurate than any previously employed methods for the determination of the presence of Koch bacilli in

the urine. The cultures have been grown upon the Hohn egg medium as well as the glycerin potato. The recipe for the Hohn egg medium is as follows:

- 1 Three fresh eggs are carefully cleansed by rubbing the end with alcohol.
- 2 The ends of the eggs are perforated with a sterile scalpel previously cleansed by careful rubbing with an alcohol sponge.
- 3 The contents of the eggs are allowed to drain into a sterile beaker, the bottom of which is covered with sterile glass pearls about the size of a small pea. By careful rotation of the flask for 3 to 4 minutes with a gentle shaking motion, the contents are thoroughly mixed (care being taken that no foam should form).
- 4 After this the contents are measured off in sterile graduates and
- 5 A third of the volume of 5 per cent acid glycerine bouillon is added.
- 6 The mixture is poured into an Erlenmeyer flask.
- 7 Five to 6 cubic centimeters is poured into a sterile test tube warmed to 84 degrees C then gradually to 87 degrees C (caution—not over!) and allowed to remain 15 minutes at this temperature.
- 8 The tube is then allowed to cool slowly at an angle so as to form a slant.
- 9 To each test tube is added 0.8 cubic centimeter of sterile bouillon without glycerine and the tube stoppered with a cotton plug.
- 10 The tubes are then tested for sterility by 24 hours incubation at body temperature and placed on ice for subsequent use.

It was our practice at first to remove the bladder urine under sterile precautions, with a catheter. But lately this method has been abandoned because the contaminating organisms which might come from the urine are rapidly destroyed by treatment with 15 per cent sulphuric acid. They are not resistant to sulphuric acid and so do not reach the culture medium. Further we need not fear confusion with smegma bacilli. In 1,200 cultures smegma bacilli were not found, nor were they found in Ziehl-Neelsen or O-O-I smears. In 45 cases smegma smears were made and stained according to the usual methods but no smegma

- 3 BREWER and WOOD *Ann Surg* 1908 *xlviii* 889
- 4 CASTELLANI *Am Med* 1928 *xxxiv* 289
- 5 CLEARY Quoted by Hurley loc cit
- 6 COPELLI *Giornale Ital delle malattie veneree e della pelle* 1912 *liii* 467 (Abst *J Cut Dis* 1913 *31* 51)
- 7 DAVIS *J Infect Dis* 1911 *viii* 190
- 8 DESJARDINS *Am J Roentgenol* 1925 *xiv* 14
- 9 DOWNING *J Am M Ass* 1918 *lxx* 85
- 10 FISHMAN and KEENE *Ann Surg* 1904 *xl* 613
- 11 EISENDRATH and ORMSBY *J Am M Ass* 1905 *xl* 1045
- 12 FREEMAN and WEIDMAN *Arch Neurol & Psychiat* 1923 *ix* 589
- 13 GILCHRIST *Johns Hopkins Hosp Rep* 1896 *i* 269
- 14 GOTO *Mitt a d med Fak. d k. Univ zu Tokyo* 1915-1916 pp 15-75 (Quoted by Wilhelmj)
- 15 HEDGE *J Am M A s* 1928 *xc* 1367
- 16 HEKTOEN *J Am M Ass* 1907 *xliv* 1071
- 17 HICKS *Lancet* 1924 *i* 128
- 18 HURLEY *J Med Research* 1915-16 *xxiii* 499
- 19 HYDE and RICKETTS *J Cutan Dis* 1901 *vix* 44
- 20 JACKSON *Arch Otolaryngol* 1926 *iii* 99
- 21 MCKEE *Internat Clin* 1926 *ii* 50
- 22 MICHELSON *J Am M Ass* 1928 *xc* 18,1
- 23 MONTGOMERY ORMSBY *Arch Int Med* 1908 *ii* 1
- 24 MONTGOMERY and RICKETTS *J Cutan Dis* 1901 *xix* 26
- 25 MOORE *Surg Gynec & Obst*, 1920 *xxix* 590
- 26 NEW *J Am M Ass* 1917 *lxviii* 180
- 27 Idem *Ann Oto Rhino Laryngol* 1928 *xxxvii* 240
- 28 PARKER, J Bone & Joint Surg 1923 *xx* 759
- 29 PREIS and FERRO *Wein klin Wchnschr* 1928 *xl* 235
- 30 PURO *J Am M Ass* 1928 *xc* 1733
- 31 RHANEY *J Am M Ass* 1926 *lxxvii* 405
- 32 RISK *New York Path Soc* 1910-11 *x* 48
- 33 SANDERSON and SMITH *Arch Dermat* 1927 *xvi* 153
- 34 SARTORY PETGES CLAUZE *Compt rend Soc de biol* 1913 *lxxxix* 179
- 35 SHILLER PEPPARD and COX *J Lancet* 1917 *xxxvii* 255
- 36 STONER, *Arch Int Med* 1914 *xiii* 507
- 37 STODDARD and CUTLER *Monographs of the Rockefeller Institute for Medical Research* 1916 January
- 38 SWIFT and BUTL *Med J Australia* 1917 *ii* 263
- 39 VINSON BROTHERS and MONTGOMERY *Surg Gynec & Obst* 1928 *xl* 7 233
- 40 WADE and BEL *Arch Int Med* 1916 *xviii* 103
- 41 WALKER and MONTGOMERY *J Am M Ass* 1902 *xxviii* 867
- 42 WEIDMAN and DOUGLAS *Arch Dermat & Syph* 1921 *iii* 743
- 43 WEISS *J Am M Ass* 1917 *lxviii* 341
- 44 WILHELMJ *Am J M Sc* 19 5, *clxix* 712

TABLE I—APPEARANCE TIME OF COLONIES ON EGG MEDIUM

Days	Tube
8	7
9 to 12	65
13 to 16	83
17 to 20	292
21 to 24	67
More than 24	27

TABLE II—APPEARANCE TIME OF COLONIES ON GLYCERIN POTATO MEDIUM

Days	Tube
18 to 21	8
22 to 28	29
29 to 35	59
36 to 42	20
More than 43	26

The cultures should be examined every 2 days. It is not necessary to moisten the egg media with the condensed water (the bouillon at the bottom of the tube), but the potato glycenn should be turned carefully every 2 or 3 days so as to moisten the inoculated surface to prevent drying. As a result of this the colonies grow more rapidly and luxuriantly.

Unless great care is used to maintain sterility the cultures may become contaminated with streptococci and staphylococci bacilli coli and other organisms as well as molds of various kinds. Due to their rapid and luxuriant growth even as early as 24 hours after contamination these colonies can spread over the surface of the medium and completely suppress the tubercle bacilli colonies even though the latter bacilli may have been present in the urine in large numbers.

The 15 per cent sulphuric acid mentioned completely destroys the contaminating organ-

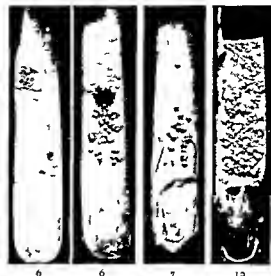


Fig 6 Human and bovine type of organism occurring in mixed culture

Fig 7 Bovine type of organism growing on egg medium

Fig 10 Human type of organism growing on glycerin potato medium

isms. Hence their appearance on the medium is evidence of careless unclean technique. It is imperative therefore that immediately after treatment of the urinary sediment with the acid we maintain a strictly sterile technique.

In the culture the tubercle bacilli appear as small pin point sized grayish white colonies (Figs 1 and 2). Often they cover the surface of the medium in the form of a pale, dull layer which is distinguishable from the surface luster of the medium in the areas in which they are developing. As the colonies grow larger and older they rise more and more from the surface coalesce in numerous places, and form verrucous structures as in Figures 3, 4 and 5. From then on their color changes according to the type of organism. The human type is

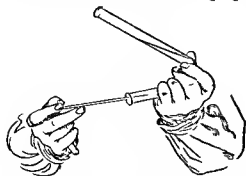


Fig 8 Showing method of inoculating the egg medium tube. The cotton stopper of the culture tube is held in the palm and little finger of the right hand.

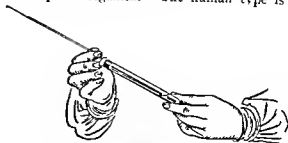


Fig 9 The cotton stopper of the culture tube is jammed on centimeter below the mouth of the tube.



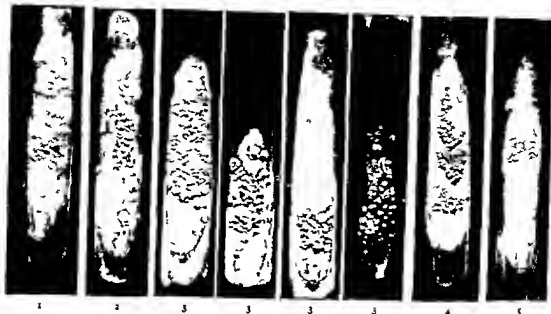


Fig 1 Human type of organism showing pin point appearance of the younger colonies

Fig 2 Human type of colony showing pin point appearance of the younger colonies

Fig 3 Human type of organism which is growing on egg

medium and which shows the verrucous character of the older colonies

Fig 4 Human type of organism growing on egg medium showing the verrucous character of the colonies

Fig 5 Colonies of human type of organism

bacilli were found. We are confident that there is no reason to fear confusion with smegma bacilli.

Tubercle bacilli are very resistant to strong inorganic acids. On many occasions the 20 minute acid treatment of the urinary sediment prescribed by Loewenstein has been far exceeded, sometimes 60 to 90 minutes being consumed. In spite of this, the cultures grew luxuriantly, even if somewhat more slowly than when the sediment was subjected to the acid treatment for only 20 minutes.

We have used the 15 per cent sulphuric acid prescribed by Loewenstein since we considered the 10 per cent sulphuric acid prescribed by Hohn as of insufficient strength.

The experiments made with Dr Gal of this clinic illustrate the great resistance of the Koch bacilli. Mature cultures of tubercle bacilli were subjected to powerful X rays. These experiments showed that after an exposure of 18 skin erythema doses the cultures still remained viable, and after transfer to a second culture tube, grew luxuriantly in 18 days despite the fact that the X rays exert a powerful destructive action on young cells. With an

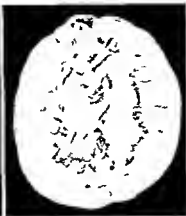
exposure of 30 skin erythema doses the bacilli were completely destroyed and failed to grow upon re inoculation in a new tube.

In making the cultures, four tubes have been used in each case so that sufficient reserve tubes might be available should one or two tubes become contaminated. Each urine specimen was inoculated upon three Hohn egg medium tubes and one glycerin potato tube. At first before the technique was sufficiently perfected the cultures sometimes became contaminated with molds, in spite of the most careful technique. Molds are apparently more resistant to sulphuric acid than tubercle bacilli because they remain viable after even one hour's treatment with the acid. If only a small mold colony grows upon the medium it does not interfere with the growth and spread of the tubercle bacilli colonies. But larger numbers of such contaminating colonies tend to spread over the surface of the medium and suppress the development of the cultures.

The optimum culture temperature of tubercle bacilli is 37.5 degrees to 38.5 degrees C. But according to our experience they also develop fairly well at 40 degrees C.



11



12



13

Fig. 11 Early form of renal tuberculosis showing a papillitis in the upper pole

Fig. 12 Early tuberculosis with papillitis in upper pole

Fig. 13 Early renal tuberculosis showing a cavity in the upper pole which is not connected with the pelvis

separated specimens. The results are shown in Table I.

The time of development is longer on potato medium, 3 to 5 weeks being necessary (Figure 10). With experience, however, one can see the colonies earlier with the aid of a magnifying glass, although this is sometimes difficult because of the similarity in color between the potato and the colony itself (Table II).

TABLE III—SUMMARY OF RESULTS

	Tabes
Egg medium cultures	900
Positive	541
Negative	280
Contaminated	39
Glycerin potato medium cultures	300
Positive	133
Negative	141
Contaminated	27

Especially important are those cases in which repeated Ziehl-Neelsen and Osol smears of the urine were negative and the cultures later proved positive. Among 200 cultures we had 50 such cases. In several cases the guinea pig test was negative and the cultures positive. This control was carried out in about 10 cases. In many cases in this latter group there was only a minimal functional defect in the diseased organ and only a small leucocyte count in the separated urines. Operation in such cases revealed an incipient renal tuberculosis, a beginning papillitis, a mild beginning granular tuberculous pyelitis, or a fresh tuberculous infarct. In a few cases histological check was necessary to confirm the diagnosis of renal tu-

berculosis. Figures 11, 12, and 13 show several such cases with early lesions. In Figure 11 a papillitis in upper pole is shown, in Figure 13 a small cavity not connected with pelvis.

Because of its absolute reliability and simplicity, the culture method is of greater value than the guinea pig inoculation method. This is easily understood when we consider how troublesome the guinea pig test is and how much longer it requires for a diagnosis. After inoculation the guinea pig is subject to epidemics to sepsis, and other infectious processes which render the results uncertain. Four to six weeks are usually necessary to establish a diagnosis. The pigs have to be controlled constantly and in addition to an autopsy a histological check may eventually be required. All of these annoyances and uncertainties are eliminated with the culture method. Further, the galinaceous type is apathogenic for the guinea pig and produces no lesions in the animals, while it produces a beautiful growth upon egg medium.

That the culture method has as yet not taken a foremost place in urologic diagnostic procedure is due, no doubt, to lack of acquaintance with the technique of culturing tubercle bacilli. But we are assured that whoever trains himself in this method and adheres to the few necessary conditions mentioned will soon be convinced of its simplicity and reliability and will consider it far superior to the guinea pig test.

grayish white, the bovine type brick red with a yellowish tinge (Fig 7) In the accompanying photomicrographs the types are distinguished by the black appearance of the bovine and the white appearance of the human type It sometimes happens that the two types occur in mixed culture but in 1,200 cultures we saw this only once (Fig 6) The bovine type is especially beautiful on glycerin potato The gallinaceous type appears as slimy, moist colonies Various foreign authors have reported the occurrence of this type In spite of the most careful search for this organism it was never found in our cultures The clinical picture of the bovine type of infection is characterized by remittent fever, low temperature in the morning and high temperature in the evening Fever reacts only slightly to antipyretics In the second stage metastatic nodules appear the sites of predilection being (1) the bone marrow, (2) the kidney, and (3) the skin In the kidney a small pinhead to pea-sized yellow nodule forms in the cortex or in the medulla These nodules may break down and give rise to cavity formation The striking feature in the reported cases is that the bladder is only slightly involved or not at all while in the human or bovine infections the involvement of the bladder is especially marked The urine contains very little pus and the bacilli appear in great numbers some times intracellularly These organisms are not pathogenic for the guinea pig and hence should be cultured according to the method of Loewenstein Sumyoshi on egg medium The growth of this organism on this medium as well as on glycerin potato is characteristic

The technique of culturing tubercle bacilli from the urine is as follows If the urine is cloudy and rich in sediment 50 to 100 cubic centimeters will suffice If however the urine is clear or slightly turbid 250 to 300 cubic centimeters is necessary The total quantity is centrifuged in divided portions From the combined sediment a Ziehl Neelsen and an Osol smear are made Then 5 cubic centimeters of 15 per cent sulphuric acid is added to the combined sediment and the whole well shaken until a homogeneous mixture forms This is allowed to stand for 20 minutes with frequent shaking The mixture

is then poured into a sterile centrifuge tube and centrifuged 3 to 5 minutes at a speed of 3,000 to 3,500 revolutions per minute The supernatant liquid is decanted and the sediment is used for the inoculation of the medium This is done with a platinum loop which is well flamed before inoculating The centrifuge tube and culture tube are taken in the left hand as in Figure 8 being so held that dust cannot drop into either tube The platinum loop with glass handle is held in the thumb and index finger of the right hand the cotton stopper removed from the culture tube with the little finger and palm of the right hand as in Figure 8 The loop is inserted into the sediment in the centrifuge tube and the culture slant streaked with a side to side motion while the loop is being withdrawn the loop not being allowed to come in contact with the condensed water The cotton stopper of the culture tube is replaced, the stopper well flamed and then jammed 1 centimeter below the top of the tube with the previously flamed glass handle of the platinum loop as in Figure 9 To prevent evaporation of the condensed water and the drying of the medium the tube is hermetically sealed by pouring melted paraffin over the stopper The procedure with glycerin potato is similar the surface of the potato being inoculated by streaking and the tube sealed in the same manner When ureter catheter specimens of urine are used smaller quantities will have to suffice

At first we washed the sediment with sterile water two to three times according to the specifications of Sumyoshi and then inoculated But since this increases the danger of contamination and since the quantity of acid which the platinum loop can transfer to the medium is so minute as not to alter appreciably the hydrogen ion concentration of the medium, we have eliminated this step Hence without being washed the sediment is immediately inoculated on the egg medium and glycerin potato Smears for diagnosis are made from the first colonies to appear The average appearance for colonies on egg medium is 8 to 20 days From the clinical material of the Illyes clinic 300 specimens of urine were cultured making a total of 1,200 tubes Of these 230 represent bladder urine and 50



Fig 1 The anterior aspect of the uterus showing the peritoneal surface elevated over the tumor by dark red and purplish lobules

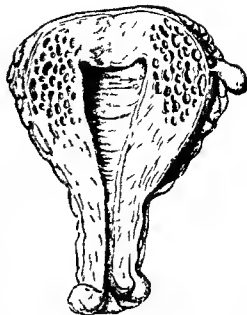


Fig 2 Section through the anterior wall of the uterus showing large caverns which were filled with blood. An arrow points to the perforation through a wall of the cavern from which the hæmorrhage occurred

follows "In the posterior wall there was a circular, elevated portion, of spongy softness, 2 centimeters in diameter, the mucous membrane covering it was thin, slightly 'hobnailed' and of bluish red transparency. The corresponding peritoneal surface was also tumefied convex, of bluish transparency and the blood vessels of the peritoneum were very distinct and full. A section made through the tissue was immediately covered with dark fluid blood after removing which a delicate framework with isolated dark spots became visible. In the cavities within the framework and communicating with each other there was fluid blood. The appearance of this tumor on the whole therefore resembles the cavernous ectasia so frequently met with in the liver excepting that the framework was much thicker than is usual in similar vascular tumors." Virchow (17) in 1867, reported another hæmangioma the size of a cherry which was purely cavernous within the substance of the uterus. Almost 30 years later

in 1893, Boldt recorded the third case in which he found a hæmangioma in the uterus of a multipara, 37 years of age, who had been bleeding for an entire year, and profusely for the past 4 months of the year. Boldt stated that on performing a vaginal hysterectomy on this patient he found a tumor in the anterior aspect of the uterus which reached to the fundus and was the size of an English walnut. It was lobulated slightly firmer than its uterine surroundings and dark red in color, mottled with purplish spots which were soft like recently coagulated blood. Many large cavities were discernible in a microscopic study of the sections. Boks, in 1917 reported a case of cavernous hæmangioma in a patient, 33 years of age, who had had two children, the second being 7 years old when the patient was examined. Menstruation had been normal up to the time an abortion occurred 4 years previously. For 6 months the bleeding had been more profuse and prolonged. The last menstruation, however, was of one day's duration and a week later severe abdominal pain set in. The patient was admitted to the

## HÆMANGIOMA OF THE UTERUS

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**H**ÆMANGIOMATA have rarely been found in the uterus. Although they occur in nearly all the tissues of the body, they are most frequently found in the skin and liver. Of the 20 cases of hæmangioma of the uterus reported in the literature, only 4 are of the true cavernous type so that the report of an additional case seems justified. An attempt will also be made to classify the recorded cases and to differentiate the true cavernous hæmangioma in the wall of the uterus from the hæmangiomatous fibromyoma in the uterus and from the telangiectatic hæmangioma of the pelvis.

Cavernous hæmangioma were first systematically studied by Rokitsansky who, when he discussed them in his *Handbuch der pathologischen Anatomie*, in 1846, and in his treatise, 'Ueber die Cavernose Blutgeschwulst,' in 1854, gave them the name 'cavernous blood tumors'. He described them as neoformations and stated that 'the anastomosis of the tumor with the venous vascular system is through very fine venous offshoots'.

MacCallum in 1924 further differentiated them. "A true hæmangioma," he stated, "is distinguished from dilation of capillaries or venules belonging to the general circulation by the fact that its blood channels grow independently without regard to the laws which govern the distribution of such vessels. It thereby forms a mass which is somewhat withdrawn from the general circulation and although supplied with artery and vein does not stand in any intimate anastomotic relation with the adjacent circulation. True hæmangioma are most commonly divided into a simple or telangiectatic form in which the abundant capillaries though widened maintain fairly well their form as tubes with parallel walls, and the cavernous form in which the character of erectile tissue is approached with large, irregular blood spaces opening abundantly into one another. It is not very apparent, however, where the line of division can be sharply drawn between these groups."

## HÆMANGIOMATA OF THE UTERUS

Virchow (18) stated that "cavernous angioma of the uterus is very rare if one does not include telangiectatic angioma." It is difficult to draw the line sharply between the true cavernous hæmangioma and the fibromyoma with dilated and tortuous vessels. The similarity between these two forms was pointed out by Kelly and Cullen, who called attention to the fact that 'the blood supply of a myoma may be so copious that the tumor in reality becomes an angiomyoma.' Reder described such a case of angiomyoma which 'looked red like a tomato was soft and felt cystic. The tumor had an enormous blood supply some sinuses being as large as a finger'.

To determine exactly the number of genuine cases of cavernous hæmangioma among the reported cases of hæmangioma of the uterus is difficult because of the frequent lack of complete pathological and histological data and because of the failure in some of the reports to distinguish between the true cavernous hæmangioma of the uterine wall without fibromyoma and hæmangiomatous fibromyoma of the uterus. In the following classification the 20 cases collected from the literature have been grouped as accurately as could be determined. Nineteen of the cases have been divided into three varieties of hæmangioma; the remaining case is a doubtful one and has been grouped separately.

- 1 The true cavernous hæmangioma in the wall of the uterus without fibromyoma to which we have added a case (Table I)
- 2 The hæmangiomatous fibromyoma (Table II)
- 3 The telangiectatic hæmangioma in the pelvis (Table III)
- 4 A doubtful case of hæmangioma in the cavity of the uterus (Table IV)

TRUE CAVERNOUS HÆMANGIOMA  
IN THE WALL OF THE UTERUS

Klob, in 1864 first described a true cavernous hæmangioma of the uterine wall as

TABLE I—TRUE CAVERNOUS HÆMANGIOMATA IN THE WALL OF THE UTERUS

Year	Author	Age of patient	Operation	Result	Pathological findings
1864	Klob		Autopsy		In posterior wall of uterus there was a circular elevated portion of spongy softness. The mucous membrane covering it was thin slightly lobulated and of bluish red transparency. The corresponding peritoneal surface was also tumefied and of bluish transparency.
1867	Vurchow		Autopsy		A tumor the size of a cherry purely cavernous within the substance of the uterine wall.
1893	Boldt	37	Vaginal hysterectomy	Recovery	A tumor in the upper anterior surface of the uterus reaching to the fundus. It was the size of a walnut lobulated dark red mottled with purplish spots.
1917	Boks	33	Abdominal hysterectomy	Recovery	A tumor in the anterior wall of the uterus.
1920	Horgan	38	Abdominal hysterectomy	Recovery	A uterus two and a half inches in diameter. A tumor about 5 cm. in diameter in the anterior wall of the uterus. The peritoneal surface elevated with dark red and purplish lobulations. The mucous membrane elevated and lobulated. A demonstrable opening into one of the blood caverns. Large blood caverns in wall of uterus.

an angioma. The removal of an angiomatous fibromyoma, 4.5 inches in diameter, together with the uterus enlarged to the size of a tump, has been reported by Shaw. The patient was a woman, 65 years of age, who had suffered extreme abdominal pain and collapse. There was atheroma of the uterine arteries. Sections showed the fibromyomatous tissue to contain a very large number of thin walled blood vessels. Microscopically, the collections of bright red blood in the tissue were found to consist of angiomatous tissue, each vessel lined with a definite layer of endothelium. Hirschberg described the case of a woman, aged 64 years, on whom a total extirpation of the uterus was performed to relieve hemorrhages which had persisted over a period of 8 weeks. An examination of the specimen showed a myoma of the uterus near the cervix. The tumor contained clotted blood with blood sinuses lined with typical endothelial tissue. In this group of cases the hæmangiomatous tissue was found to be within fibromyomata which were either interstitial, submucous, or subperitoneal (Table II). In the true cavernous hæmangiomas of the first group, the hæmangiomatous tissue was in the uterine wall and no other tumor was present.

#### TELANGIECTATIC HÆMANGIOMATA OF THE PELVIS

In a discussion of telangiectatic hæmangiomas the cases recorded by Horie, Pantzer,

and Wright are of interest. In 1906, Horie reported a case of hæmatoma on the anterior wall of the uterus of a patient 35 years of age. When the abdomen was opened the uterus was found to be about the size of a 4 months' pregnancy, its elevated portion formed by a fluctuating mass. A longitudinal incision in this mass allowed a large amount of black, tar like blood to escape. The cavity of the hæmatoma did not communicate with the uterine cavity. As the removal of the uterus was thought inadvisable, drainage was established through the abdominal wall from the incision which was not closed. Oozing of blood continued up to the time of the patient's death 3 weeks later. Autopsy was not performed and the true pathological condition was not determined. Pantzer, in 1911, reported a case of telangiectatic hæmangioma in the pelvis of a patient 26 years of age. The hæmangioma was found to be in the peritoneum covering the front of the uterus, the right half of the bladder, the right fallopian tube and the contiguous portion of the right broad ligament. He ligated the right ovarian and right uterine arteries and placed a suture in the uterine wall encircling the tumor. Two years later he had occasion to observe the result of the ligations when he operated on this patient for acute appendicitis. He found the hæmangioma to have entirely disappeared although there were some enlarged vessels in the right broad ligament. An interesting case was reported by Wright of a patient operated



Fig. 3. Photomicrograph of tissue from the anterior wall of the uterus showing numerous large caverns in the hemangioma. The larger caverns are toward the peritoneal surface. One fairly large cavern can be seen under the mucous membrane.



Fig. 4. Photomicrograph of the wall of a cavern of the hemangioma showing its endothelial lining.

hospital because of hemorrhage. At operation a tumor was found in the anterior wall of the uterus. Much blood escaped from the tumor when it was incised. A study showed it to be a cavernous hemangioma (Table I).

#### HEMANGIOMATOUS FIBROMYOMATA

Virchow (17), Oulie, Michel, Reder, Bell and Clarke, Shaw and Hirschberg have each reported one case and Kelly and Cullen have reported 5 cases of hemangiomatous fibromyomata of the uterus. Virchow (17) in 1867 reported his observations on the pure cavernous hemangiomata of the uterine wall and the hemangiomatous fibromyomata. In 1901 Oulie reported a case in which a dissection of the uterus revealed a fibroma the size of an almond, in the fundus. The tumor was permeated by numerous engorged vessels with thrombosed veins at its periphery. The tumor, which was probably associated with an abortion, was reported as an angiomatous fibromyoma although in the discussion Jeannel refers to it as a "deciduoma." Two years later in 1903, Michel reported the removal of

a tumor from a woman 45 years of age whose only symptom had been menorrhagia. The tumor which had grown rapidly to the size of a child's head and which Michel called a uterine fibroid was found in the anterior wall of an enlarged uterus. The tumor had a large number of capillaries and isolated small muscle fibers and microscopically it resembled placental tissue. The angiomatoma found by Reder which was red like a tomato has been referred to above. The tumor was large with an enormous blood supply. When Reder thinking it a cyst punctured it he had difficulty in controlling the hemorrhage but succeeded in doing so and in removing the tumor. Under the title "Angiomatous Fibromyoma of the Uterus" Bell and Clarke reported a case in 1900 of a woman aged 41 years on whom a hysterectomy was performed to remove a uterine tumor. The bulk of the tumor consisted of unstriped muscle fibers but some portions of it were very vascular. Kelly and Cullen have mentioned briefly 4 cases of angiomatoma and have given a detailed report of a fifth case. In this case a large tumor was situated in the left uterine wall. Scattered throughout the tumor were numerous dark blue vascular areas varying from 0.5 to 1.5 centimeters in diameter. The areas were composed of blood vessels present in a honeycombed appearance the individual vessels of widely varying diameters being closely packed together. The walls of the vessels were smooth and glistening. The entire picture the authors thought suggested

TABLE III—TELANGEICTATIC HÆMANGIOMATA IN THE PELVIS

Year	Author	Age of patient	Operation	Result	Pathological findings
1906	Horne	35	Exploratory laparotomy. Open 1 g. of hematoma and packed with gauze	Death	A fluctuating mass in front of the uterus. The mass was incised and about 300 grams of tarlike black blood came out. No common cavity with uterine cavity.
1910	Pantzer	26	Ligation of right ovarian and right uterine arteries and suture of uterine wall around tumor	Recovery	A telangiectatic angioma under the peritoneum covering the front of the uterus (the right half of bladder, the right tube and the contiguous part of the right broad ligament).
1926	Wright	35	Removal of tumor and uterus	Recovery	A mass on the right broad ligament below the tube and ovary and intimately associated with the uterus. It was smooth and glistening of rubbery consistency and bluish black in color.

TABLE IV—DOUBTFUL CASE OF HÆMANGIOMA IN THE CAVITY OF THE UTERUS

Year	Author	Age of patient	Operation	Result	Pathological findings
1906	Delval and Stan	34	Abdominal hysterectomy		The uterine walls hypertrophied and fibromatous. A tumor the size of a large nut in the uterine cavity. It (1) was examined in touch and it to be an angioma. Bend recalled it a place tal polyp.

When her second child was born she had a post partum hemorrhage about 1 hour after delivery which was controlled by ergot. One week after her third child was born, when she was 23 years old she had a sudden hemorrhage from the vagina the flowing being profuse for several days. Ice bags were applied to the abdomen and ergot was administered. When the patient was 24 she underwent an operation for the removal of the right ovary and fallopian tube. She had not menstruated for 4 months previous to this operation, but 2 months later menstruation began again and remained normal for 4 years. Then at the age of 28 the patient had a sudden and severe vaginal hemorrhage. For 15 minutes or more the blood gushed violently. It then began to clot and many large clots were passed. The bleeding caused considerable weakness. A hypodermic injection of a drug was given in the arm by the attending physician and the vagina was packed. The packing had to be renewed daily because of the profuse flow of blood. The bleeding stopped after 5 days. Three or 4 years later the patient had another sudden hemorrhage the bleeding continuing for several days although it was not as severe as the previous one had been.

The patient became pregnant at the age of 34 and went to full term being delivered in April 1913 normally and without complications. Six months later in October there was another sudden hemorrhage 1 week after menstruation which lasted for several days and forced the patient to remain in bed. The vagina was again packed. Following this attack the menstrual flow was normal and there was no intermenstrual bleeding up to the menopause in January 1924. As stated before 'spotting' was observed in May of that year.

On December 12 1924 while seated talking to a friend the patient had a sudden and profuse gush

of blood from the vagina which thoroughly saturated her clothes and continued for some time with lessening force. She was treated with morphine hypodermically and with ergot. Two further gushes occurred during the ensuing week. After the onset, the bloody vaginal discharge remained continuous and confined the patient to her bed up to the time she was seen in consultation 19 days later.

**Physical examination.** The patient was a middle aged woman fairly well developed although not well nourished. Her skin and sclera showed a yellow tinge and her breasts were small and wrinkled. The findings of the heart and lungs were within normal and the abdominal wall was only slightly rotund. There was a low midabdominal operative scar. On palpation of the abdomen no areas of tenderness or masses were detected. On pelvic examination the introitus was found to be relaxed because of an old laceration of the perineum. There was a profuse bloody vaginal discharge with clots. The cervix was enlarged and fairly soft. The uterus was about twice its normal size with its fundus forward and not freely movable. The left appendage could not be distinctly felt.

**Laboratory observations.** The clinical laboratory examinations showed the urine to be normal the blood to contain 3 500 000 red cells per cubic centimeter and the hæmoglobin to be 40 per cent. On January 2 1925 the patient was given 500 cubic centimeters of citrated blood intravenously.

**Operation.** On January 3 1925 the abdomen was opened through a low midline incision. Exploration revealed numerous adhesions of the omentum on the anterior surface of the uterus and the broad ligaments. These were separated with difficulty the separation causing considerable bleeding. The uterus was found to be about twice its normal size with a soft lobulated tumor mass in the anterior



TABLE II—HEMANGIOMATOUS FIBROMYOMATA

Year	Author	Age of patient	Operation	Result	Pathological diagnosis
1867	Vucbow				Telangiectatic myoma
1901	Ould	25	Abdominal hysterectomy		Angiomatous fibroma
1903	Michel	45	Abdominal hysterectomy		Angiomyofibroma
1904	Reder		Abdominal hysterectomy	Recovery	Angiomyoma
1906	Bell and Clarke	41	Abdominal hysterectomy	Recovery	Angiomatous fibromyoma
1909	Kelly and Cullen		Hysterectomy		Angiomatous fibromyoma
1909	Kelly and Cullen		Hysterectomy		Angiomatous fibromyoma
1909	Kelly and Cullen		Hysterectomy		Angiomatous fibromyoma
1909	Kelly and Cullen		Hysterectomy		Angiomatous fibromyoma
1909	Kelly and Cullen		Hysterectomy		Angiomatous fibromyoma
1913	Shaw	65	Abdominal hysterectomy	Recovery	Angiomatous fibromyoma
1914	Hirschberg	64	Hysterectomy	Recovery	Hemangioma

on by Dr T S Cullen. This patient was a white woman, aged 38 years, who had a cystic tumor to the right of, and posterior to, the uterus. At operation "a mass was found in the right broad ligament. It was found to be vascular and any attempt to separate it from the uterus produced marked hemorrhage. A supravaginal hysterectomy was performed, the tumor and uterus being removed without disturbing their relationship." The pathologist reported a tumor in the right broad ligament made up of large cavernous blood vessels, microscopic study of the tissue showed "blood spaces filled with blood elements the supporting structure being connective tissue forming trabeculae" (Table III).

#### A DOUBTFUL CASE OF HEMANGIOMA IN THE CAVITY OF THE UTERUS

Siegel, Delval, and Marie in 1906, reported that they considered to be a uterine angioma in a patient, 34 years of age on whom they performed a subtotal hysterectomy. The uterine walls were hypertrophied and fibromatous. The tumor which was found in the uterine cavity on the anterior wall was the size of a large nut, soft, vascular and surrounded by a clot. The histological examination showed an angioma filled with hema-

tin crystals. Bender who saw the specimen and discussed the case called it a placental polyp (Table IV).

#### CASE REPORT

A white woman aged 46 years was seen in consultation with Dr Milton H. Prosser on January 1, 1925. The patient was confined to bed and had been since the sudden onset of a vaginal bloody discharge on December 12, 1924. The patient's family history had no bearing on the case, neither was there any history of blood or circulatory disease except in the patient's mother who had died of arteriosclerosis at the age of 72 years.

**Menstrual history.** Menstruation began when the patient was 14 years of age. It was of regular occurrence and of 4 to 5 days duration. The flow was free with no cramps, backache or headache. Menopausal pause occurred in January, 1924 although a few drops of blood were noted in May of that year.

**Marital history.** The patient who was married when she was 17 years of age had had four pregnancies all except the last one terminating a few weeks before the full term. The patient's four children, three daughters and one son and her husband were all living and well.

**Personal history.** As a child the patient had had whooping cough and measles at 14, malaria and at about 21 she frequently had had sore throat. In July 1902 the right ovary and fallopian tube were removed. The patient had always been in fairly good health and was able to nurse all her children and do her own housework.

**History of illness.** The patient experienced no difficulty with her first labor at the age of 19 years.

## CLINICAL EXPERIENCE WITH NEW LOCAL ANÆSTHETIC DRUGS

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IN the production of novocain the efforts of workers in the field of synthetic drugs have been rewarded with decided success. For several years this drug has most nearly fulfilled the requirements of the ideal local anæsthetic, rendering the use of cocaine for infiltration anesthesia almost obsolete. One of the most important advantages is the possibility of safely injecting large quantities of the solutions. This factor has been largely responsible for the development of regional anesthesia to its present scientific basis.

The toxicity of novocain, however, is not an entirely negligible factor. When local infiltration was limited to minor operations, the injection of small quantities of weak solutions kept the method well within the limits of safety. But with the introduction of regional methods, larger quantities of stronger solutions have been employed.

While the safety of these methods have been repeatedly demonstrated, the sphere of usefulness would still be further extended by the introduction of a drug even less toxic than novocain. It is reasonable to expect that synthetic chemists will produce such a drug. Many intended substitutes for novocain have been produced recently by research chemists and have been subjected to pharmacological investigation. McElvain and his co-workers at the University of Wisconsin have produced upward of 30 such preparations.

In initiating this research, it was believed that a series of local anæsthetics, combining within their structure the groups known to give anesthesia with various nitrogen rings allied to the ring found in cocaine would include one or more compounds which would give the powerful anæsthetic effect of cocaine without its toxicity.

In general, these substances are piperidino or substituted piperidino alkyl benzoates and piperidyl or substituted piperidyl benzoates. All contain the piperidino or piperidyl groups with any substitutions being made in the 2 (alpha) or 3 (beta) positions. They resemble

cocaine and procaine in having the necessary benzoyl or aminobenzoyl groups and particularly cocaine, in containing a nitrogen ring, which is absent in procaine. The local anæsthetic No. 33C (gamma 2 methyl piperidino propyl benzoate hydrochloride), to be discussed specifically later, differs in addition from procaine in not having the benzoyl group substituted. The chemical preparation of these anæsthetics may be found in the papers of S. M. McElvain and co-workers.

The merit of any substance for local anesthesia should be determined by the following standards originally formulated by Braun: (1) the drug must produce a diffusible, complete, and lasting anesthesia; (2) following systemic absorption it should be less toxic than cocaine in proportion to its anæsthetic power; (3) it should not produce irritation and painful infiltration (anesthesia dolorosa) or cause local tissue damage, but should be absorbed without after effects such as hyperemia, exudation, or necrosis; (4) it should be soluble in water and its solution should be stable; (5) it should be readily sterilizable by heat, preferably in solution; (6) unless more powerfully anæsthetic and at the same time less toxic than any known substance, the drug should be compatible in solution with adrenalin.

The research workers of a prominent pharmaceutical house performed extensive laboratory experimentation on these drugs and then submitted their data to me for selection of those compounds most likely to give satisfaction in clinical use. While animal experimentation is of great value in the determination of toxicity and local tissue effects, the ultimate efficiency of a new drug will depend upon its action in practical use. In general, experiments performed upon laboratory animals show greater variation and are therefore of less value than those performed upon man.

Ten of these preparations were selected for trial because of low toxicity and high anæsthetic power. The anæsthetic potential was first determined by dermal wheals on the

wall. The right tube and ovary had been removed. Exploration of the abdomen did not reveal any other pathological condition. The entire uterus with the left tube and ovary were removed. The patient was dismissed from the hospital in 15 days.

**Pathological report.** The specimen was that of the uterus, the left tube and the ovary. The uterus was about twice its normal size. The surface of its anterior wall was raised by a tumor mass within the wall, about 5 centimeters in diameter. Its peritoneal surface was elevated with dark red and purplish lobules. On section the surfaces showed large caverns filled with blood (fig. 1). The mucous membrane of the anterior wall was elevated and lobulated. There was a demonstrable opening from one of the blood caverns into the cavity of the uterus (fig. 2). A microscopical examination showed numerous large caverns lined by a thin endothelial layer and supported by connective tissue trabeculae (figs. 3 and 4). The pathological diagnosis was cavernous hæmangioma in the wall of the uterus.

September 24, 1929, the patient was in good health and had had no vaginal discharge since the operation.

#### TREATMENT

No treatment other than hysterectomy has been advised for hæmangioma of the uterus when this procedure can be carried out with safety. In the reported cases of true cavernous hæmangiomata in the wall of the uterus, there has been no difficulty in doing hysterectomy nor has there been any difficulty in doing myomectomy or hysterectomy in the reported cases of hæmangiomatous fibromyomata. Telangiectatic hæmangiomata of the pelvis, on account of the extensive involvement of the pelvic structures, have presented a difficult condition to treat surgically when they could not be removed. In Hone's case, the tumor was opened and packed in Pantzer's ligation of the right ovarian and the right uterine arteries and suture of the uterine wall had to be used to lessen the amount of blood supplying the area involved. The use of radium for any one of these varieties of hæmangiomata has not been reported.

#### SUMMARY

Aside from its rarity, the case being reported is interesting because the aperture in the wall

of a cavern of the hæmangioma allowed an escape of blood into the cavity of the uterus. This aperture in the wall more than likely resulted from a gradually increasing tension within the cavern with a corresponding stretching of the wall, thereby producing necrosis of a small area and finally perforation with hæmorrhage. The aperture which was clearly demonstrated in the uterus removed at operation suggests the possibility of the previous hæmorrhages having occurred through similar openings.

#### BIBLIOGRAPHY

1. BELL W. BLAIR and CLARKE H. H. Angiomatous fibromyoma of the uterus. *J Obst & Gynec Brit. Emp.* 1906 ix 348.
2. BOKS D. B. Angioma van de Baarmoeder. *Nederl Tijdschr v Gynec.* 1917 lxx 694.
3. BOUNT H. J. Cavernous angioma of the uterus. *Am J Obst.* 1893 xlviii 834.
4. HIRSCHBERG H. Hæmangioma uteri. *Zentralbl f Gynaek.* 1924 xlviii 957.
5. HORIE TOMA. Ein Fall von Angioma uteri. *Mitt d med. Gesellschaft zu Tokyo.* 1906 xx 370.
6. KELLY and CULLEN. Myomata of the uterus. Philadelphia W. B. Saunders Company 1909 p. 158.
7. KLOS J. M. Path. Anat. der weiblichen Sexualorgane. Wien Wilhelm Braumüller 1864 p. 173.
8. MACCALLUM W. G. A Text book of Pathology. Philadelphia W. B. Saunders Company 1924 3d ed p. 1162.
9. MICHEL. Angiomyofibroma uteri. *Verhandl d gyn. nat. Gesellsch. Bresl.* 1903 4 p. 77.
10. OUTLET. Fibrome angiomateux de l'utérus. *Toulouse méd.* 1901 iii 18.
11. PANTZER H. O. Angioma of the uterus bladder and broad ligament. *Am J Obst.* 1911 lxxv 768.
12. RADER F. Specimen of angio-myoma of the uterus. *Med. Fortnightly.* 1904 xiv 53.
13. ROBITANSKY CARL. 1904. *Handbuch der pathologischen anatomie* 3 v. Wien Bei Braumüller & Seidel 1846 vol. 1 p. 276.
14. Idem. Ueber die Cavernöse Blutgeschwulst und einen gemeinlich als Teleangiectasia angesehenen gefäss-tumor. *Ztschr. d. k. k. Gesellsch. d. Aerzte zu Wien.* 1854 vii 256-271.
15. SHAW W. FLETCHER. Hæmorrhages into an angiomatous fibromyoma of the uterus and atrophy of the uterine arteries. *J Obst & Gynec.* 1913 xxiv 22.
16. SIEGEL DELVAL MARIE I. Angiome Uterus. *Bull. Soc. anat. de Par.* 1906 lxxxi 403.
17. VIECHOW RUDOLF. Die Krankhaften Geschwulste. Berlin A. Hirschwald 1863-64, vol. iii p. 195.
18. Ibid p. 308.
19. WRIGHT F. W. Hæmangioma of the uterus. *Surg. Gynec. & Obst.* 1916 xliii 282.

TABLE IV—APPLICATION AND RESULTS IN  
VARIOUS TYPES OF CASES

Operations	Amount in c cm	Per cent of strength	Drops of adrenalin per 100 c cm	Anæ- sthesia	After effects
Excision of pigmented wart	10	3/4	0	Good	0
Drainage of abscess	8	3/4	0	Good	0
Drainage of abscess	5	3/4	0	Good	0
Suture of wound	10	3/4	0	Good	0
Cautery of wart	5	3/4	0	Good	0
Excision of small pedunculated lipoma	10	3/4	0	Good	0
Excision of small epithelioma of back	15	3/4	0	Good	0
Excision of small sebaceous cyst of neck	30	3/4	0	Good	0
Excision of two small warts of scalp	30	3/4	0	Good	0
Removal of bull's-eye wart	40	3/4	0	Good	0
Drainage of abscess	10	3/4	0	Good	0
Insertion of tube in chest for emphysema	10	3/4	0	Good	0
Excision of nodule of neck for biopsy	15	3/4	0	Good	0
Excision of venereal wart	8	3/4	0	Good	0
Excision of hairy birth mark of chest	30	3/4	0	Good	0
Drainage of abscess	5	3/4	0	Good	0
Tonsillectomy	40	3/4	10	Good	0
Tonsillectomy	45	3/4	10	Good	0
Excision of hydrocele	60	3/4	0	Good	0
Drainage of abscess of neck	0	3/4	0	Good	0
Partial cyst of sacrum	50	3/4	0	Good	0
Excision of nodule of breast	30	3/4	0	Good	0
Excision of anal fistula	20	3/4	0	Good	0
Excision of the subcutaneous hemorrhoid	15	3/4	10	Good	0
Excision of gland of neck	50	3/4	10	Good	0
Repair of umbilical hernia	90	3/4	10	Good	0
Excision of pedunculated lipoma	0	3/4	0	Good	0
Removal of ingrowing toenail	0	3/4	0	Good	0
Bilateral inguinal herniotomy	00	3/4	10	Good	0
Simple amputation of breast	15	3/4	10	Good	0
Excision of Bartholin's abscess	50	3/4	0	Good	0

TABLE IV—Continued

Operations	Amount in c cm	Per cent of strength	Drops of adrenalin per 100 c cm	Anæ- sthesia	After effects
Strangulated inguinal herniotomy	150	3/4	10	Good	0
Resection of rib and curettage of sinus of chest wall	100	3/4	10	Good	0
Amputation of terminal phalanx of finger	25	3/4	0	Good	0
Inguinal herniotomy	80	3/4	10	Good	0
Inguinal herniotomy	100	3/4	10	Good	0
Thyroidectomy—thyroidectomy	150	3/4	10	Good	0
Inguinal herniotomy	100	3/4	10	Good	0
Resection of hydrocele	110	3/4	10	Good	0
Suprapubic cystostomy	100	3/4	0	Good	0
Right inguinal hernia	175	3/4	10	Good	0
Secondary suture of wound	40	3/4	0	Good	0
Excision of nodule of breast	50	3/4	0	Good	0
Excision of pleural cyst	40	3/4	10	Good	0
Reduction of fracture of radius	30	3/4	0	Good	0
Circumcision	10	3/4	0	Good	0
Excision of lipoma of back	90	3/4	10	Good	0
Bilateral inguinal hernia	250	3/4	10	Good	0
Hæmorrhoidectomy	75	3/4	10	Good	0
Excision of anal fistula	65	3/4	10	Good	0
Resection of varicocele	100	3/4	10	Good	0
Strangulated femoral hernia	100	3/4	10	Good	0
Strangulated femoral hernia	110	3/4	10	Good	0
Simple bilateral amputation of breast	100	3/4	10	Good	0
Curettage of sinuses of breast	120	3/4	10	Good	0
Removal of pedunculated tumour of leg	100	3/4	10	Good	0
Repair of umbilical hernia	150	3/4	10	Good	0
Secondary closure and amputation stump	100	3/4	0	Good	0
Exploratory laparotomy	150	3/4	10	Good	0
Exploratory laparotomy	175	3/4	10	Good	0

TABLE I—COMPARATIVE ANÆSTHETIC POWER DETERMINED BOTH BY DURATION OF ANÆSTHESIA IN MINUTES AND MINIMAL ANÆSTHETIC CONCENTRATION

Drug	Dilutions in physiological salt solution—per cent							
	1	1/2	1	3/4	1	1 1/2	2	4
Novocain	25	20	15	8	5	0	0	0
O	30	25	20	14	11	7	0	0
45B	40	36	22	18	15	6	7	0
56	41	41	40	33	28	8	5	0
33C	33	25	21	16	12	8	6	5
50	45	36	35	20	12	3	7	7
27B	27	27	15	22	22	5	0	0
74	32	30	24	22	25	2	0	0
34C	30	30	21	15	7	5	7	0
56C	41	34	30	32	17	0	3	0
37	22	18	25	13	20	4	0	0

The letters refer only to different numbers of the same compound.

TABLE II—DURATION OF ANÆSTHESIA IN ONE QUARTER AND ONE SIXTEENTH PER CENT STRENGTHS AFTER BEING BOILED FIVE MINUTES

Drug	Per cent		Drug	Per cent	
	1/4	1/16		1/4	1/16
Novocain	12	6	Novocain	2	6
O	24	20	27B	23	7
45B	0	15	74	29	14
56	25	15	33C		5
33C	17	15	56C	5	15
50	37	11	52		8

human skin. This is an attractive method because it parallels clinical usage. It involves direct action on the terminal nerve filaments and sensory end organs of the skin. Anæsthesia is but very little dependent upon pressure within the layers of skin because control wheals of physiological salt solution do not produce anæsthesia. Anæsthesia therefore results from a direct chemical action upon the nerve endings. By this method anæsthetic potential may be determined both by duration and by minimal anæsthetic concentration.

#### TECHNIQUE

The thighs and anterior abdominal wall were closely shaved. Dermal wheals were

TABLE III—DURATION OF ANÆSTHESIA OF ONE HALF PER CENT STRENGTHS OF NO. 33C WITH THE ADDITION OF 5 DROPS 1:1000 ADRENALIN TO 100 CUBIC CENTIMETERS

Drug	Per cent	Drug	Per cent
	1		1
Novocain	20	Novocain	20
O	40	27B	43
45B	30	74	55
56	05	33C	50
33C	05	56C	28
50	6	37	62

then raised with a special local anæsthesia syringe and finest hypodermic needle. The needle was thrust beneath the skin surface with bevel downward. At the moment the needle point entered the epidermis injection began, which was always endermic and not subcutaneous. The area of wheals was estimated as the size of a dime and required 0.8 cubic centimeters of solution each. It is important that all wheals be as nearly the same size as possible and contain the same amount of solution all of which has been injected intracutaneously. Adequate controls were employed consisting of novocain and salt solution, so that a mere disturbance of sensation was not interpreted as anæsthesia. Progressive series of dilutions in physiologic salt solution were injected as 1/2, 3/4, 3/8, 1/16, 1/11, 1/44 and 1/111 of one per cent.

All wheals were made upon the writer by himself. The skin of thighs and abdominal wall is of such thickness that accurate wheals may be raised painlessly when the substance is anæsthetic. The sensitiveness of the skin and the rapidity of absorption vary in different areas of the body. It also varies in different individuals depending upon familial traits, exposure, vocation, etc. By employing the same skin area in the same individual these factors remain constant. The duration of anæsthesia in the same cutaneous area may also be shortened by previous brisk massage, heating or muscular exercise because of the improved circulation and consequently more rapid absorption. In these tests the subject remained seated and sources of external heat were avoided. Wheals were marked with a

# CLINICAL SURGERY

FROM THE SURGICAL SERVICE NEW YORK HOSPITAL

## A TECHNIQUE FOR SUBTOTAL THYROIDECTOMY IN EXOPHTHALMIC GOITER

EUGENE H. POOL, M.D., F.A.C.S., NEW YORK

A VARIETY of methods are followed by experienced operators in performing subtotal thyroidectomy for Graves' disease. Most of these are reliable and relatively safe as carried out by an extremely skilled surgeon, especially the one who has devised or developed the method. But in this field it is particularly difficult to emulate an outstanding operator and to do the operation with the same degree of skill as he. An effort has therefore been made to develop a procedure which may be followed with reasonable assurance of success by the average operator.

The chief requirements of the operation are expedition, control of hemorrhage at all times, adequate removal of thyroid tissue, and preservation of the parathyroid glands and recurrent laryngeal nerves. Expedition and control of hemorrhage will minimize immediate dangers. Remote failures notably persistence or recurrence of symp-

toms, are often due to insufficient removal of thyroid tissue. Only a small portion of each lateral lobe should be left and this must be a definite part, namely that which is in relation to the recurrent nerves and parathyroids. The parathyroids usually lie in or on the posterior surface of each lobe and the recurrent nerve runs from below upward from the posterior to the mesial aspect of this posterior part.<sup>1</sup> Therefore, on anatomical grounds the part to be left is definitely indicated (Fig. 1), namely the posterior and posteromesial portions. This forms a triangular mass on cross section leaving the portion which is in contact with the lateral aspect of the trachea. The preservation of this part with careful technique will prevent tetany and avoid injury to the recurrent nerves.

The method which is presented is reasonably simple and appears to meet the indications. While much of the procedure is employed by others notably, Richter, certain details are not generally recognized. Each lobe is freed. This is done by dividing the isthmus and dissecting it from the trachea. The superior thyroid vessels are ligated

Fowler and Hans. *N. Surg. Gynec. & Obst.* 1929, xl, 59.



1

Fig. 1. Approximate line of division when posterior part of lobe is left so as to safeguard the parathyroids and recurrent laryngeal nerve. 1, parathyroid; B, thyroid; C, posterior of trachea; D, oesophagus. Recurrent nerve lies between thyroid and trachea.  $\times 8$ .



Fig. 2. Curved transverse incision.

circle of mercurochrome as soon as raised so that the center of the endermic infiltration was easily identified for testing after the wheal had disappeared. Tests for sensation were made by scratching the area with a wooden applicator or with a needle as is done in vaccination.

Table I expresses both duration of anæsthesia and minimal anæsthetic concentration. Novocain was used as a basis of comparison, physiologic salt solution as a control. The figures indicate duration of anæsthesia in minutes. It will be seen that all substances are more powerfully anæsthetic than novocain and that No. 33C and No. 50 are more powerful than all.

Table II shows the duration of anæsthesia in  $\frac{1}{4}$  and  $\frac{1}{16}$  per cent strengths after being boiled for 5 minutes. It will be observed that all retain their anæsthetic potency after sterilization by boiling.

Table III shows the duration of anæsthesia of the  $\frac{1}{2}$  per cent strengths after the addition of adrenalin, in the proportion of 5 drops of the 1:1000 solution to 100 cubic centimeters of anæsthetic mixture. It will be observed that novocain is potentiated more than any of the other drugs in the proportion to its anæsthetic power alone. Nos. 56 and 56C were made more irritating by the addition of adrenalin. Irritation with these was so marked that necrosis and sloughing of the wheal area resulted. This would, of course, prohibit its use in clinical work.

The results of these tests indicate the superiority of No. 33C. It was so reported to the pharmaceutical house and they then began the manufacture of No. 33C in an amount sufficient for clinical trial. Its further suitability and ultimate efficiency should then depend upon its action in practical clinical work.

In the employment of any new drug in clinical work, it should first be used in terminal infiltration. The total amounts of

solution are different in terminal infiltration, field block, and nerve block. The technique of injection also influences the production of toxic symptoms. When the solution is distributed within the operative field proper, much of it escapes when the parts are incised and more is sponged from the tissues. But when the anæsthetic is deposited a distance from the operative field as it is in the regional method, the total quantity injected is absorbed. In certain regions the absorption is more rapid than in others, for example in the sacral canal and on either side of the vertebral column, a fact which accounts for a great likelihood of toxic manifestations in paravertebral and sacral anæsthesia.

The following operations were performed by the terminal infiltration method. Dermal wheals were first raised with finest hypodermic needles, after which the underlying tissues were well infiltrated. Further infiltration was carried out as necessary during the course of the operation. These operations were painlessly performed, there were no indications of toxic effects whatsoever during the operation and no interference with healing afterward. Clinical experiences are thus far very encouraging. It is now used routinely in all local anæsthetic work at the Mobile City Hospital and it is planned to use it in sacral and spinal anæsthesia.

#### CONCLUSIONS

Local anæsthetic drug No. 33C (gamma 2 methylpiperidino propyl benzoate hydrochloride) produces a diffusible complete and lasting anæsthesia, it compares favorably with novocain in systemic toxicity, it causes no local tissue damage or consequent interference with healing, its solutions do not deteriorate by boiling, and are compatible with adrenalin. Clinical experience thus far is very favorable and if it continues as satisfactory in more widespread use this drug promises to be the local anæsthetic of choice.

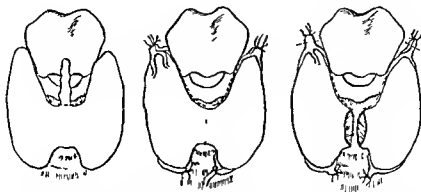


Fig 8 Diagrams showing division of fascia above isthmus division of tissues mesial to lateral lobe and division of isthmus

roid (Fig 4) This can be done readily near its attachment to thyroid cartilage No effort need be made to repair the muscle at the close of the operation

The steps of the operation are as follows

Curved transverse incision (Fig 2) of appropriate length depending upon the size of the gland The incision should not be so low as later to fall into the depression between the clavicles The incision is carried through the deep fascia The large anterior jugular veins and, in some cases, the lateral jugular veins are encountered and are divided between clamps The ribbon muscles are then widely exposed (Fig 3) by separating and lifting the upper flap, if necessary, as high as the incisure of the thyroid cartilage The sternohyoids are then separated in the midline and retracted

As they are retracted the mesial borders of the sternohyoids are encountered somewhat laterally In large glands this muscle may be very much thinned and at times it is adherent to the thyroid, and in such cases it may be somewhat difficult to recognize it While the sternohyoid is retracted, the mesial edge of the sternohyoid is dissected free If the two muscles are then elevated with a retractor the insertion of the sternohyoid is usually well defined, as in illustration (Fig 4) The muscle is divided close to its insertion The sternohyoid is then stripped from the lobe by blunt dissection The same procedure is done on the opposite side



Fig 10 The whole lobe is easily lifted.

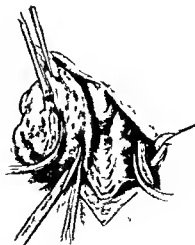


Fig 11 Clamps placed near extreme posterior part of lobe and gland cut and removed anterior to them





Fig. 3



Fig. 4



Fig. 5

Fig. 3 Wide exposure of ribbon muscles  
 Fig. 4 Petraction of sternohyoid and division of sterno-thyroid

Fig. 5 Division of pyramidal lobe and fascia above isthmus

and divided. The inferior and middle thyroid veins are ligated and cut and the outer surface of the lobe freed. The whole lobe may then be lifted thus demonstrating clearly the part to be left. Resection, leaving any amount which is desired can then be done readily with little hæmorrhage and with easy control of such bleeding as occurs.

One feature in the exposure must be emphasized. The sterno-thyroid is inserted along the oblique line of the thyroid cartilage. In this area

it is in close relation to the mesial aspect of the upper part of the lateral thyroid lobe. As the muscle is here fixed obviously it cannot be retracted so as to give adequate exposure of the upper part of the gland. For this reason many surgeons divide both the sternohyoid and sterno-thyroid muscles. A little reflection will convince one that the sternohyoid having a much higher insertion may be widely retracted and that it is in general necessary to divide only the sterno-thyroid.

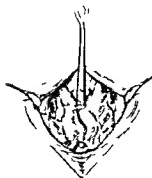


Fig. 6

Fig. 6 Insertion of special curved clamp

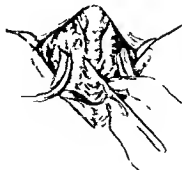


Fig. 7

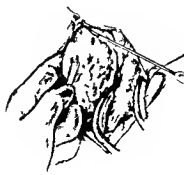


Fig. 9

Fig. 7 The isthmus is clamped on either side and divided  
 Fig. 9 The superior pole is ligated and divided

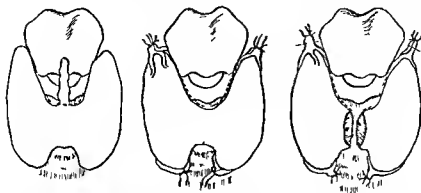


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Fig 10 The whole lobe is easily lifted

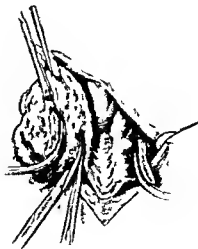


Fig 11 Clamps placed near extreme posterior part of lobe and gland cut and removed anterior to them



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Fig. 3 Wide exposure of ribbon muscles.  
 Fig. 4 Retraction of sternohyoid and division of isthmus thyroid



FIG. 4



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FIG. 6

Fig. 6 Insertion of pectus curved clamp

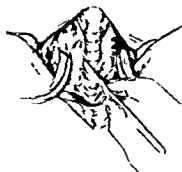


FIG. 7

Fig. 7 The isthmus is clamped on either side and divided.  
 Fig. 9 The superior pole is ligated and divided



FIG. 9

FROM STATE UNIVERSITY OF IOWA COLLEGE OF MEDICINE

## FLEXOR PLASTY OF THE THUMB IN THENAR PALSY

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**E**LEVEN years ago<sup>1</sup> and in the years following the writer proposed a new operative procedure for the relief of one of the most disturbing disabilities of the hand, namely thenar palsy.<sup>2</sup> Because of its simplicity and reliability he considers the method of definite value in the treatment of this condition.

The most disabling feature of thenar palsy is the inability of the thumb to execute opposition movements. Even the more primitive motions of the hand depend upon opposition of the thumb; this, indeed, is one of the principal functions of the thenar muscles. It is true that to a limited degree, opposition may be substituted by other muscles. The lack of the abductor and of the short flexors of the thumb may be partly compensated by the action of the adductor of the thumb together with the long flexor. These muscles are not capable of placing the end of the thumb in opposition to the tips of the little and fourth fingers, but they enable the thumb to be held against the radial side of the index finger so that the holding of objects between the two fingers becomes possible. The condition is some what better if the short flexor of the thumb is functioning but in neither case is opposition of the thumb substituted by the long flexor and the adductor to a degree at all comparable with the normal nor is it satisfactory for every day use.

It was for these reasons that the writer 12 years ago conceived the idea of substituting the lost opposition action by a portion of the long flexor of the thumb. The indication for the operation is the presence of a well functioning long flexor of the thumb. The technique is as follows:

The incision is made along the radial side of the thumb beginning at the level of the interphalangeal joint and reaching proximally to a point about one half inch beyond the metacarpophalangeal joint. The lateral cutaneous nerve of the thumb can easily be avoided. By retracting the skin toward the ulnar side the long flexor of the thumb is exposed as it lies in its sheath. It is followed up above to its insertion into the end phalanx and below to the point where it emerges from under the short thumb muscles. In dissect-

ing the tendon proximally care should be taken to avoid injury to the branches of the median nerve as they enter the thenar group, in case part of the thenar group has escaped paralysis.

The sheath of the long flexor of the thumb is now incised its full length and the tendon exposed. The edges of the sheath are caught by fine forceps. The tendon is lifted out and is carefully split longitudinally into two equal halves commencing distally close to its insertion, and continuing proximally as far as the thenar muscle group. Next, the radial half of this tendon is freed at the distal end by cross incision and is brought out of the sheath (Fig. 1). The sheath of the long flexor is now reunited over the remaining half of the tendon by means of fine interrupted silk or catgut sutures, the radial flap emerging through a hole in the reconstructed sheath (Fig. 2). This radial tendon flap brought out of the sheath is attached to the periosteum of the basal phalanx in the following manner. The thumb is adducted maximally and both phalanges are fully flexed. This position is carefully maintained throughout the remainder of the operation and also during the postoperative fixation. Then with a curved forceps, a tunnel is made into the soft part around the dorsal aspect of the basal phalanx of the thumb and a short longitudinal incision (one half inch) is made down upon the point of the forceps. The free radial flap of the long flexor tendon is carried through this tunnel the end of the tendon is roughened, and under normal tension it is now sutured through the second dorsal incision above the metacarpophalangeal joint of the basal phalanx, about one fourth of an inch above the metacarpophalangeal joint (Fig. 3). For this purpose silk is used. One may pass the tendon through a drill hole into the phalanx as one wishes but it has not seemed to be necessary in the cases we have operated upon. Both incisions are closed in layers. The hand is bandaged in the position described, namely, with the thumb in full flexion both in the metacarpophalangeal and interphalangeal joints and the thumb metacarpal in full adduction. The thumb should be, as it were, entirely buried in the palm and must be left in this position for 3 weeks. After 3 weeks muscle exercises and active and passive motion are instituted.



Fig. 12. Resection completed

The pyramidal lobe and fascia above the isthmus are then divided so as to expose the trachea (Fig 5). The pyramidal lobe is subsequently removed. A special curved clamp is usually passed down along the trachea between it and the isthmus without hemorrhage (Fig 6). The isthmus is clamped on either side of this and divided. The two halves of the isthmus are then dissected from the anterior aspect of the trachea with little or no bleeding (Fig 7). (We have never noted trachitis from the removal of the whole of the isthmus and in several cases where some of the isthmus has been left a recurrence has been noted in this tissue with marked deformity.) Clamps are then placed close to the mesial aspect of the lobe above the isthmus and the tissues divided between them. The superior pole is ligated and divided (Fig 9). The whole lobe is then readily lifted as the lateral portion slides mesially (Fig 10). The middle thyroid veins are ligated and divided and the lobe then is attached by a small vertical posterior portion. After the large inferior veins are ligated re-



Fig. 13. Michel clips are used for skin sutures double forceps facilitating their application

section is readily done. One method which is usually satisfactory for this step is as follows: clamps are placed from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch from the extreme posterior part of the lobe and the gland cut and removed anterior to them (Fig 11). Only three or four clamps are necessary. Complete hæmorrhage is usually easily secured by mattress sutures passed through the tissues beneath the clamps. The same procedure is performed on the other lobe (Fig 12). The sternohyoids are brought together and sutured in midline.

A drain is usually introduced. It is placed laterally and is drawn in by a curved clamp which is passed between the muscles and brought out under the anterior margin of the sternomastoid. On removal of the drain this muscle slips over the tract and prevents adhesion of the superficial to the deep parts with the resulting depression or dimple. The fascia is united with fine chromic sutures and the skin with Michel clips. We have found it useful to use the double forceps in applying the clips. This enables the operator to hold the two edges of the skin wound in apposition with one hand, while he applies the clips with the other.



Fig 4 Traumatic ulnar palsy Pre operative (b) maximum opposens action possible

Fig 5 Seven months after operation a Range of abduction b patient can now touch fifth finger with considerable power

the ulnar side of the thumb but prefer the radial side of the thumb as there is less danger of subsequent scar contraction. In our earlier cases occasionally a scar contraction over interphalangeal and metacarpophalangeal joints of the thumb developed, but did not materially interfere with its opposition ability. If the incision is placed on the radial side of the thumb this can be avoided. Also it must be remembered that the liberated tendon slip should be passed well around the radial side to the back of the basal phalanx.

The average time of observation of all cases

was 4 years, but many of the cases have been observed for a much longer period, the earliest case dating from May 17, 1917. These statistics show that the results in general were sufficiently satisfactory to warrant the recognition of this method.

In later years two other methods have been advocated namely, that of Ney and of Bunnell. Without abrogating the merits of these methods which are both admirably conceived and thoroughly rational, the writer, nevertheless, recommends his own method for its simplicity and reliability of results.

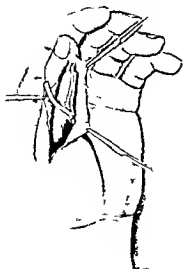


Fig. 1. Thenar plasty. Freeing of the radial flap of the flexor longus pollicis.

#### STATISTICS

In the last 13 years this operation was carried out 23 times

Volkman's contracture  
Traumatic paralysis  
Infantile paralysis  
Birth palsy

Cases  
2  
4  
16  
1

The result of the operation was, on the whole, thoroughly satisfactory

Results  
Good and excellent  
Fair  
Failure

Cases  
15  
6  
2

Per cent  
65  
27  
8

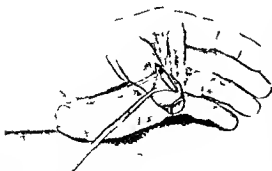


Fig. 3. Fixation of the radial flap into pericardium. Tension properly obtained with full flexion of thumb in all joints.



Fig. 2. Tendon sheath reconstructed over remaining ulnar half of flexor longus pollicis. Radial half tunneled around the back of the phalanx.

The analysis of the failures is of interest. In the one case of birth palsy, failure was due to improper indications. The principal condition of a well functioning long flexor of the thumb did not obtain. In the other case, one of infantile paralysis the failure was due to adhesions which were formed following prolonged immobilization after operation, and interphalangeal contracture resulted. Re operation was not permitted.

We believe that most of the failures are due to two factors: either improper indications that is, absence of the long flexor of the thumb, or, neglect of after treatment, especially insufficient immobilization. It cannot be emphasized too strongly that the thumb must be held in the palm in flexed position after the operation for at least 3 weeks, since otherwise the tendon slip implanted into the base of the phalanx will not subsequently develop proper tension.

The kinetic effect of the flexor plasty of the thumb is readily understood. The tendon slip deflected to the back of the basal phalanx acts exactly in the direction of the opponens pollicis. Upon contraction the long flexor of the thumb will therefore not only flex the end phalanx but will also cause the metacarpal to swivel over the greater multangular by means of this detached tendon slip. This swivelling motion will carry the tip of the thumb into opposition to the tips of the little and ring fingers when full flexion of the thumb is executed (Figs. 4 and 5).

Since the earlier description of the operation several minor details of the technique have been introduced.<sup>1</sup> We no longer place the incision over

<sup>1</sup> Nils Silvertholm (Acta chirurg. Scand. 1918, 26) has practiced a modification wherein the entire end of the long flexor is transplanted. However, loss of flexion of the end phalanx results.



Fig. 1 Extensive involvement of almost the entire stomach



Fig. 2 The resected specimen showing the duodenum at the left and the esophageal opening at the right

stomach was suitable for anastomosis it was necessary either to remove the entire stomach or to do nothing. The duodenum was divided about 1 centimeter below the pylorus and the duodenal stump was closed. The stomach was then freed from its omental attachments throughout its entire length. By using the stomach as a tractor about 4 centimeters of the lower end of the esophagus could be seen below the diaphragm. A Brunner right angle rubber covered clamp was placed on the esophagus as high as possible and the esophagus was then severed about 1 centimeter above the cardiac sphincter. The stomach was then free and was removed (Fig. 2). The proximal loop of the jejunum was next brought up through an opening made in the transverse mesocolon and its side was anastomosed to the distal end of the esophagus with the use of one continuous row of silk and one row of chromic catgut sutures. A few interrupted silk sutures were added for reinforcement. A small jejunal tube was passed through the mouth down the esophagus and into the distal loop of the jejunum for a distance of about 15 centimeters below the anastomosis and was left in place.

Crossly the walls of the stomach were thickened non elastic and leathery. Although the entire stomach was involved the process was most marked in the distal third where the wall was 2 centimeters thick and the lumen was reduced to a rigid tube approximately 2 centimeters in diameter. An ulcer 10 by 8 by 4 millimeters was situated on the posterior wall near the lesser curvature at the junction of the proximal and middle thirds of the stomach. The lymph nodes were not found to be involved. Microscopic examination showed the typical diffuse scirrhous carcinoma of the linitis plastica type with carcinomatous cells infiltrating the submucous and muscular layers of the wall of the stomach (Figs. 3 and 4).

Convalescence was uneventful. Fluids were given by proctoclysis and 1000 cubic centimeters of 10 per cent glucose solution was given intravenously daily for 8 days. Small amounts of water were introduced through the jejunal tube on the sixth day. The amount was gradually increased until on the ninth day 2700 cubic centimeters of liquid nourishment including milk and cream, broth, fruit juices and water was given through the tube without distress. There was complete absence of nausea and vomiting. The jejunal tube was removed on the twelfth day and feeding was continued by mouth. On the sixteenth day soft and semisolid foods were given. The patient left the hospital on the twenty second day in good general condition. At that time she was taking her feedings at ninety minute intervals 2500 calories daily without discomfort. In a recent letter 40 days after the operation the patient reported that she was feeling well, gaining in strength and eating four meals each day. Untoward symptoms have not appeared.

#### INDICATIONS FOR TOTAL GASTRECTOMY

In a review of the cases in the literature in which the stomach has been removed completely it is found that practically all the operations were done for diffuse scirrhous carcinoma of the leather bottle or linitis plastica type. In a few cases a large ulcerating adenocarcinoma of a low grade of malignancy was found without lymphatic extension or apparent metastasis. In one case Butler removed the entire stomach for a lesion that proved to be a large benign ulcer. In linitis plastica where the disease is characteristically local with very little tendency toward extension beyond the stomach or metastasis until late in the course of the disease complete gastrectomy offers the only chance of cure. The results of palliative or

At the last report from the patient 9 months after operation she stated that her general health was good. Her diet had been general and she was taking four meals a day without any digestive symptoms. The only drawback phase of the report was the fact that she had lost 15 pounds weight.



TOTAL GASTRECTOMY WITH REPORT OF A SUCCESSFUL CASE<sup>1</sup>

E STARR JUDD M.D. F.A.C.S. ROCHESTER MINNESOTA

AND

JAMES M. MARSHALL M.D. ROCHESTER MINNESOTA

Fellow in Surgery The Mayo Foundation

**I**N spite of the fact that 45 years have passed since Conner performed the first total gastrectomy in man, only about 70 cases have been reported in the literature. Conner's patient moribund at the time of operation, died on the operating table. Thirteen years later Schlatter performed the first successful gastrectomy. His patient lived nearly 14 months and then died of recurrence of carcinoma. This case proved that the entire stomach could be removed successfully, that a functioning oesophago-enterostomy could be accomplished and the subject live in comparative comfort and health without a stomach.

Czerny and Kaiser in 1878 did pioneer work in total gastrectomy by planning and executing the operation in dogs. They attempted removal of the entire stomach and anastomosis of the oesophagus to the duodenum. One of their dogs lived 5 years, but at necropsy a small pouch of gastric tissue was found even though they had felt certain at the time of operation that the removal had been complete. Nevertheless their experiments were fundamental and pointed the way toward interesting physiological studies in gastrectomized animals. They also proved that the operation was technically feasible and of possible value in dealing with extensive malignant lesions of the stomach. Curvillo and Pachon, in 1895, and others since have successfully performed the operation in cats and have proved histologically postmortem that the entire stomach had been removed. They concluded that the animal was quite healthy without a stomach except that it had to be coaxed to eat and that although the stomach was not essential to digestion it might play a part in the initiation of appetite and hunger pains. Mann at The Mayo Clinic has devised a two-stage operation for use in dogs that renders the procedure much less difficult. At the present time he has 3 dogs on which total gastrectomy was performed more than 4 years ago. The general health of all 3 animals is excellent. The erythrocyte count and percentage of haemoglobin have remained within normal limits. He concludes that a dog without a stomach becomes just as hungry as a dog with a stomach and also that the gastrectomized animal can vomit just as a normal dog can.

We use the term total gastrectomy here only in reference to those cases in which the entire stomach has been removed. Many operations have been reported as total gastrectomy which in reality were subtotal gastrectomies because a small portion of the cardiac or pyloric end of the stomach was not excised. Finney and Rienhoff have carefully reviewed 67 cases from the literature in which they believed total gastrectomy had been performed. Since then Stahnke has reported a case. Six total gastrectomies had been previously performed in the clinic. The most successful was the operation performed by W. J. Mayo. His patient lived 4 years and was in reasonably good health during that time. Walters has recently performed the operation and his patient is alive and well 23 days after operation. Because of the rarity of this operation we are reporting the case of a patient operated on by one of us (Judd) 5 months ago.

A woman aged 62 years came to the clinic July 9, 1920 complaining of stomach trouble of 10 months duration. The onset had been rather insidious. There had been dull gastric pain in the mid epigastrium with some gas and belching coming along regularly 2 to 3 hours after meals. It could be relieved only by taking more food. There had been no vomiting since the onset but rather a steady and progressive increase in the severity of the symptoms. Gradually the patient had noticed that the capacity of the stomach was decreasing and during the 3 months prior to admission regurgitation had frequently taken place if too much had been eaten at one time. Alkalies of various kinds had been taken without relief. There had not been hæmatemesis or melæna. She had lost about 10 pounds most of it in the last 3 months.

On examination the patient appeared to be fairly well nourished. She weighed 118 pounds. A firm freely movable slightly tender mass was palpable in the epigastrium just above the umbilicus. Fractional gastric analysis showed maximal total acidity to be 38 and free hydrochloric acid 12. Roentgen ray examination revealed an extensive scirrhus type of carcinomatous deformity involving almost the entire stomach (Fig. 1). The haemoglobin was 77 per cent, erythrocytes numbered 4,430,000 and the leucocytes 6,200 and the differential count was normal. Examination of the urine was negative as were the Wassermann reaction of the blood and roentgenogram of the chest.

At operation July 13, 1920 the stomach was found to be somewhat reduced in size. Its walls were thickened throughout and the entire stomach was evidently involved with a diffuse scirrhus carcinoma of the intussus plastica type, a typical leather bottle stomach. Lymph nodes could not be felt and there was no evidence of intra-abdominal extension or metastasis. Since no portion of the



Fig. 1 Extensive involvement of almost the entire stomach

stomach was suitable for anastomosis it was necessary either to remove the entire stomach or to do nothing. The duodenum was divided about 1 centimeter below the pylorus and the duodenal stump was closed. The stomach was then freed from its omental attachments throughout its entire length. By using the stomach as a tractor about 4 centimeters of the lower end of the esophagus could be seen below the diaphragm. A Brunner right angle rubber covered clamp was placed on the esophagus as high as possible and the esophagus was then severed about 1 centimeter above the cardiac sphincter. The stomach was then free and was removed (Fig. 2). The proximal loop of the jejunum was next brought up through an opening made in the transverse mesocolon and its side was anastomosed to the distal end of the esophagus with the use of one continuous row of silk and one row of chromic catgut sutures. A few interrupted silk sutures were added for reinforcement. A small jejunal tube was passed through the mouth down the esophagus and into the distal loop of the jejunum for a distance of about 15 centimeters below the anastomosis and was left in place.

Crossly the walls of the stomach were thickened, non-elastic and leathery. Although the entire stomach was involved the process was most marked in the distal third where the wall was 2 centimeters thick and the lumen was reduced to a rigid tube approximately 2 centimeters in diameter. An ulcer, 10 by 8 by 4 millimeters was situated on the posterior wall near the lesser curvature at the junction of the proximal and middle thirds of the stomach. The lymph nodes were not found to be involved. Microscopic examination showed the typical diffuse scirrhous carcinoma of the linitis plastica type with carcinomatous cells infiltrating the submucous and muscular layers of the wall of the stomach (Figs. 3 and 4).



Fig. 2 The resected specimen showing the duodenum at the left and the esophageal opening at the right

Convalescence was uneventful. Fluids were given by proctoclysis and 1000 cubic centimeters of 10 per cent glucose solution was given intravenously daily for 8 days. Small amounts of water were introduced through the jejunal tube on the sixth day. The amount was gradually increased until on the ninth day 2700 cubic centimeters of liquid nourishment including milk and cream, broth, fruit juices and water was given through the tube without distress. There was complete absence of nausea and vomiting. The jejunal tube was removed on the twelfth day and feeding was continued by mouth. On the sixteenth day soft and semisolid foods were given. The patient left the hospital on the twenty-second day in good general condition. At that time she was taking her feedings at ninety minute intervals, 2500 calories daily without discomfort. In a recent letter 40 days after the operation the patient reported that she was feeling well, gaining in strength and eating four meals each day. Untoward symptoms have not appeared.

#### INDICATIONS FOR TOTAL GASTRECTOMY

In a review of the cases in the literature in which the stomach has been removed completely it is found that practically all the operations were done for diffuse scirrhous carcinoma of the leather bottle or linitis plastica type. In a few cases a large ulcerating adenocarcinoma of a low grade of malignancy was found without lymphatic extension or apparent metastasis. In one case Butler removed the entire stomach for a lesion that proved to be a large benign ulcer. In linitis plastica where the disease is characteristically local with very little tendency toward extension beyond the stomach or metastasis until late in the course of the disease, complete gastrectomy offers the only chance of cure. The results of palliative or

At the last report from the patient 40 days after operation she stated that her general health was good. If diet had been general and she took four meals a day without any gastric symptoms. The only serious stage of the report was the fact that she had not gained in weight.



Fig 3 A section from the stomach wall showing the typical diffuse infiltration of the carcinomatous cells ( $\times 50$ )

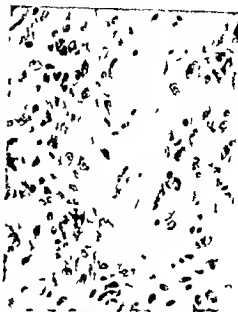


Fig 4 Same section as shown in Figure 3 ( $\times 250$ )

incomplete operations in these cases have been uniformly disappointing

#### TYPES OF OPERATION

Oesophagojejunostomy is probably the operation of choice in most cases. In an analysis of the end results, Finney and Rienhoff found that of 26 patients in whom the oesophagus was anastomosed to the jejunum 58 per cent recovered and 47 per cent died as compared to the 30 patients on whom oesophagoduodenostomy was done and of whom 47 per cent recovered and 53 per cent died. In 9 cases in which anastomosis was not done the oesophageal stump being closed and either the duodenum or jejunum brought out and sutured to the skin, all the patients died, either from shock or from a spreading infection from the oesophageal stump. Usually the jejunum has been brought up through an opening made in the transverse mesocolon as is done in ordinary posterior gastrojejunostomy, but a few successful cases have been reported in which an antecolic anastomosis had been done. In most cases oesophagoduodenostomy would be a more difficult procedure because of the difficulty in getting sufficient mobilization of the duodenum to prevent tension on the line of anastomosis.

#### COMPLICATIONS

Patients on whom total gastrectomy is done are often poor surgical risks. Twenty five per cent of the deaths in the reported cases have been attributed to surgical shock. Of the immediate postoperative complications peritonitis is the most common it caused approximately 60 per cent of the deaths. Haemorrhage oesophageal fistula and duodenal fistula are rare complications. Rienhoff and Kocher each reported a case of persistent postoperative stomatitis which progressed to eventual enteritis and death. In Reid's case stomatitis was a distressing complication for several weeks but the patient recovered and lived 18 months. Most of the patients who have lived have seemed to have had strikingly uneventful courses. Vomiting was mentioned in only a few instances.

Changes in the blood similar to those seen in pernicious anaemia have been commented on by Moynihan and Hartman as late complications. Moynihan's patient lived 3 years and 8 months and at necropsy evidence of profound anaemia was found. There was complete absence of recurrence of the carcinoma and practically no dilatation of the jejunum that had been used for the anastomosis. Hartman reporting on one of W J Mayo's patients studied the changes in the blood carefully over a considerable period. The patient lived 4 years after the operation and

apparently died from the anæmia, but details concerning the death were not available. Mann and Graham performed gastrectomy on dogs that lived more than 4 years apparently in good health without signs of anæmia or other physiological disturbance.

#### RESULTS

Complete follow up data are not available in many of the reported cases so that an accurate analysis of the end results cannot be made. Zikoff's patient lived 4 years and 8 months. W. J. Mayo's patient lived 4 years, and Moynihan's 3 years and 8 months. Perhaps some have lived longer. Most of the patients who are reported to have lived for longer periods have had "almost" total gastrectomy, a small portion of the cardiac end of the stomach having been left. Most of the patients of whom we have records, that have survived the operation, have eventually died of a recurrence of the carcinoma. However, it is a fact often mentioned in the case reports that these patients live in apparent comfort and good health except during the last few weeks before death. They take a wide variety of food even three meals a day are sometimes taken with little if any, digestive or metabolic disturbance.

#### BIBLIOGRAPHY

- 1 BUTLER, H. B. Brit J Surg 1927 xv 316-324
- 2 CARVALLO J and PACHON, V. De l'extirpation totale de l'estomac (une observation chez le chat) Arch de physiol norm et path 1895 vu 349-355
- 3 CONNER, P. S. Cancer of the stomach gastrostomy gastro enterostomy Med News 1884 xlv 578
- 4 FINNEY J. M. T. and RIEVHOFF W. F. Jr. Total gastrectomy Arch Surg 1929 xviii 140-162
- 5 HARTMAN H. R. Blood changes in a gastrectomized patient Am J M Sc 1921 clxii 201-206
- 6 KAISER F. T. Beitrage zu der Operationem am Magen In Czerny V Beitr z oper Chir, 1878 93-160
- 7 KOCHER THEODOR. Total excision des Magens mit Darmresection combinirt Deutsche med Wchnschr 1890 xxv 606-610
- 8 MANN F. C. Total gastrectomy Proc Staff Meetings Mayo Clinic 1929 iv 294-295
- 9 MOYNIHAN B. G. A. Lancet 1911 ii 430-431
- 10 REID M. R. Total gastrectomy Surg Gynec & Obst 1925 xli 667-672
- 11 SCHLATTER CARL. Ueber Ernahrung und Verdauung nach vollstaendiger Entfernung des Magens Oesophagoenterostomie beim Menschen Beitr z klin Chir 1897 xix 757-776 complete removal of the stomach successful oesophago enterostomy recovery Med Rec 1897 lii 909
- 12 STAHLKE E. N. Ein Fall von totaler Magenresektion Deutsche Ztschr f Chir, 1928 ccvi 408-410
- 13 ZIKOFF V. M. Complete excision of the stomach Novoye v Med 1911 v 67-72.

## BIFID OS CALCIS

JAMES WARREN SEVER, M.D., F.A.C.S., BOSTON

IT is my purpose to call attention to a hitherto undescribed condition of clinical importance, which should not be confounded with a disease the result of a pathological process. Three cases are presented which were discovered during routine X-ray studies of patients at the Children's and Infants' Hospital.

I have carefully investigated all available and pertinent literature and have been unable to find a description of such a condition. My associates in roentgenology recall seeing no previous examples.

## DEVELOPMENT OF OS CALCIS

According to Cray, the epiphyseal center of the body of the os calcis appears at the sixth month of the fetal life and the center for the posterior tuberosity at about the tenth year. No mention is made of a double center of the body of the os calcis.

Keibel and Mall in their book *Human Embryology*, state that the chief center of the calcaneus develops at the sixth month. They state that the chief nucleus is endochondral and also that a periosteal nucleus appears frequently in the fourth and fifth fetal month. It is generally agreed that the center for the posterior tuberosity appears at about the age of 10 years but as has been shown by X-ray studies<sup>1</sup> at the Children's Hospital several years ago that is usually 3 years too late.

Bifid os calcis is significant from a clinical standpoint as the condition may be easily mistaken for a fracture the result of a fall or of some other injury to the foot. The condition may not be mistaken for fracture in the very young children but a diagnosis of fracture may be made in children who are walking. Roentgenograms of both feet should always be taken. If present the condition is usually found to be bilateral.

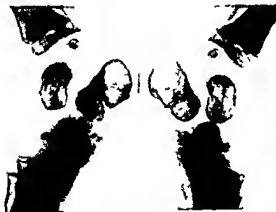


Fig. 1. Roentgenogram, October 11, 1926, Case 1.



Figs. 2 and 3. Roentgenograms of Case 2.

<sup>1</sup>J. W. Sever. *Apophysitis of the os calcis*. New York: M. J. 1917.



Fig. 4. Roentgenogram of Case 3.



Figs. 5 and 6. Os calcis removed in Case 3.

CASE 1. E. P. aged 2 years reported to the Out Patient Department at the Children's Hospital with the history of having fallen down stairs a week previously. Physical examination revealed no apparent injury. The patient was referred to the orthopedic department for treatment of the feet as both feet were badly pronated. The child showed a limp on walking but there was no swelling and no local tenderness when she walked. X-ray pictures were taken which showed bifid ossa calcis. The line of separation divided the anterior one third from the posterior two thirds. Patient was treated for pronation and a year later October 1927 X-ray pictures were taken of the carpal bones to see whether development was normal. At that time patient was 3 years of age. He showed only two centers of ossification in the carpal bones which according to Priors table denotes delayed anatomical development. However the cleft in both ossa calcis had fused and disappeared. He was seen and roentgenographed 1 or 2 years later and no further abnormality was observed (Fig. 1).

CASE 2. An infant 8 months old a full term child weighed at birth 6½ pounds but was an idiot. Roentgenograms (Figs. 2 and 3) showed bilateral bifid ossa calcis with the line of cleavage between the anterior one third and the posterior two thirds as in Case 1. No other anatomical change was observed.

CASE 3. D. N. 10 months old male entered the hospital February 27, 1929. The child was a patient at the Infants' Hospital being treated for leukemia. He weighed at birth 8 pounds and was full term child of normal delivery. He had a large spleen and liver and the usual blood picture of leukemia. In the course of routine X-ray examination the bifid condition of the ossa calcis was discovered. The child eventually died and we were fortunate enough to obtain one oss calcis.

The roentgenograms showed both feet with the usual type of bifid oss calcis as described above. Figures 5 and 6 show the oss calcis removed but no real signs of cleavage in the gross specimen. Figure 6 shows the oss calcis sectioned longitudinally and demonstrates the separation clearly. This line of separation or septum was cartilaginous in nature.

The pathological report on the gross specimen and section through the septum is as follows: The bone was carefully removed and on external examination appeared to be quite normal in form. It was composed chiefly of cartilage and on the external surface no true bone was found (Fig. 5). The specimen was split at right angles to the defect which was seen in the X-ray film. The ossified portion of the bone cut with exceptional ease. The cut surface presented two centers of ossification, the largest measuring 11 by 12 millimeters and the smaller 4 by 7 millimeters. Separating these centers of ossification was a septum 1.5 millimeters in width composed of a whitish gray cartilage like tissue (Fig. 6). Microscopically the bone consisted of a normal cartilaginous shell in which were the two centers of ossification. The septum being composed of cartilage fibrous tissue and bone. The bone in some portions was completely ossified in others it consisted of a new bone matrix and in some areas merely of osteoblastic tissue. The bone spicules were heavier and more numerous on the septal sides than along the peripheral borders. The remaining portion of the septum consists of cartilage and fibrocartilaginous tissue which in places shows evidence of beginning bone formation. The ossified portions of the bone contain only a few well formed bone spicules and an abundant active marrow. The anomalous condition of the



Figs. 7 and 8. Photomicrographs of specimen in Case 3.

bone while it now shows an abnormal ossification does not however appear to be a diseased process but rather a congenital condition which in the course of time would be lost had the child lived (Figs. 7 and 8).

Here then we have a new, and so far as I know, an undescribed developmental condition. It may be associated as in Case 1 with other anatomical delays of ossification. If the patient lives the defect disappears probably by the time he is 3 years of age. Before that age, it is important that the condition be recognized and that in case of injury it be distinguished from fracture.

When the first case was observed one foot only had been examined with the X-ray and I believed we were dealing with a most unusual fracture of early childhood.

I am indebted to Dr. Vogt of the X-ray Department of the Children's Hospital Boston for the X-ray plates and to the Pathological Department for their interest in the pathological reports on these cases.

## SPONTANEOUS FRACTURES OF THE OS CALCIS

## BILATERAL OSSEO ARTHROPATHIES IN A TABETIC PATIENT

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THE subject of this communication was an apparently healthy woman, aged 54, who presented herself at the University Hospital on April 12, 1929 with a slightly painful swelling of her left ankle and the history that in November 1928, she had twisted her foot between two boards. After the injury there was considerable swelling and she treated the condition as a sprain and continued to walk. The swelling however, did not completely disappear. One day in February, 1929, while walking, she felt something "slip" in the left ankle and there was some pain and sudden swelling. Of late she had been able to be on her feet only for about half the day because she tired easily. The foot was painless, however.

## CLINICAL PROGRESS

**Examination.** She walked into the clinic. The left foot showed an edematous swelling surrounding the ankle and a small ecchymosis over the head of the astragalus. The ankle joint showed slight loss of dorsiflexion and there was marked diminution of subastragaloid joint movement. No tenderness could be elicited. There was no evidence of any other joint involvement. The blood Kahn reaction was negative. A ray examination was made the lateral view of which is reproduced (Fig. 1). It will be observed that there was an oblique comminuted fracture of the os calcis with compression of this bone and involvement of the subastragaloid joint. There was bone sclerosis at the fracture site, some apparent absorption of the posterior edge of the astragalus and marked osseous proliferation and fragmentation extending upward behind the astragalus deep to the tendo achillis. A diagnosis was made of spontaneous fracture of the left os calcis and the possibility of a neurotrophic joint was considered. No evidence of malignant disease elsewhere being found and the pupils being observed not to

react to light the cerebrospinal fluid was examined and its Kahn reaction was 4 plus. In addition to this and the remarkable absence of pain in the left foot there was loss of ankle jerk and of deep tendo achillis tenderness on the right side. Neurological examination by Dr. C. D. Camp confirmed the diagnosis of tabes dorsalis.

**Operation upon the left foot.** It was decided to arthrodese the subastragaloid joint. On April 2, therefore, I exposed this joint through Kocher's incision, dividing the peroneal tendons and the external lateral ligament. There was considerable scar tissue and much irregularity of the posterior articular surface of the os calcis with the piled up osteophytic mass behind it. The fracture site was exposed as a deep groove running anterior to this articular surface and ending in a pit like excavation at the tarsal sinus. From this two sequestered portions of bone were removed. The cartilage was now removed from the articular surfaces of the subastragaloid joint together with neighboring bony excrescences and the wound closed.

**Postoperative course.** The painless nature of the postoperative course was noteworthy and the wound healed by first intention. The patient was discharged on June 19 with the left foot in a cast after having a course of antibiotic treatment. On July 3 a brace was fitted to the left leg. On July 24 she returned on account of edema of the right leg and ankle. This was considered to be of purely circulatory origin as there was no history or evidence of trauma and X-ray examination was negative. A reproduction of this view is given in Figure 3.

On August 24 the patient returned having had for 2 days swelling and instability of the left knee and it was evident that she had a neurotrophic lesion here. The left foot showed excellent healing with bony ankylosis of the subastragaloid joint (Fig. 2). While waiting for a brace for the left knee she drew our attention once more to the swelling of the right ankle which although painless now showed considerable thickening of the os calcis and definite interference with subastragaloid movement. New X-rays were taken on August 23 and a well marked transverse fracture of the os calcis was demonstrated with considerable sclerosis and irregularity of the bone ends (Fig. 4).

**Operation upon the right foot.** On August 28 I operated upon the right foot. Much disorganization was found at



FIG. 1. Left foot before operation.

FIG. 2. Left foot four months after subastragaloid arthrodese.

FIG. 3. Right foot July 24, 1929.

FIG. 4. Right foot August 23, 1929. Roentgenogram taken before operation.

the fracture site the line of which passed immediately behind the posterior articulation of the subastragaloid joint. There was some upward displacement of the posterior fragment and much soft scar tissue between the bone surfaces. The cartilage was removed from the subastragaloid joint and the scar tissue from the fracture. The fragments were approximated and the wound closed.

*Pathological report by Dr A. S. Warthin on tissue removed from the left os calcis:* A chronic osteoarthropathy. A vascular granulation tissue filling marrow spaces and causing necrosis and absorption of the bone. Not a pyogenic osteomyelitis but probably a syphilitic osteitis.

In view of the last phrase of this report and the view that I held from the clinical standpoint that this was a neurotrophic lesion, I was much interested to know Dr Warthin's opinion upon the right foot, which was as follows:

*Spec. 1 (Soft tissue from capsule):* Chronic productive inflammation with necrosis of bone, marked fibrosis, degeneration of cartilage, vascular granulation tissue. Possibly syphilitic.

*Spec. 2 (Bone after decalcification):* Chronic productive osteitis with necrosis of bone, new formation of atypical

bone and cartilage. Vascular fibrosis of marrow spaces. Most probably syphilitic but no gummatous areas found.

In conversation Dr Warthin told me that he regarded these lesions to be of the type usually classified as Charcot joints but that in his opinion, apart from the neurotrophic condition, there is usually a local syphilitic process.

#### SUMMARY

This case is remarkable (1) on account of the multiplicity of the lesions which from the clinical point of view are neurotrophic, (2) upon the rapidity of onset of the lesion in the right foot as demonstrated by the roentgenograms taken at an interval of one month and (3) the satisfactory healing both of bone and soft tissues after operation.

*NOTE:*—Since the above article was written this patient has had further misfortune, this time sustaining (on the 25th of November) a spontaneous fracture of her right tibia and fibula at their upper end. This occurred while she was standing quite still supporting her weight on crutches. The condition of the feet remains excellent.

## SOLITARY TUBERCULOMA OF THE BLADDER

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AND

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Department of Pathology, Peter Bent Brigham Hospital and Harvard Medical School

**B**ECAUSE of the difficulty encountered in differentiating solitary tuberculoma from carcinoma of the bladder without microscopic examination and because after a careful search through the literature we have been unable to find any mention of this condition, the following case is reported:

Mr M. I. P., Surgical No. 33744, a white male aged 47 years entered the hospital April 15, 1929, complaining of hematuria. The family history was irrelevant. The past history was negative except that about 10 years ago he had a series of abscesses of the scrotum which were incised and drained and which finally cleared up after about 8 months.

The onset of his present illness occurred about 5 weeks ago with frequency, nocturia, and slight burning on urination. These symptoms gradually increased in severity and about 2 weeks ago he had a brisk hemorrhage from the urethra. The hematuria was total for about 36 hours then gradually disappeared. He has had two similar attacks since then. His general health has remained unaffected.

The physical examination was quite negative except for large ragged tonsils, slight induration of the left epididymus

and several scars over the left scrotum and slight tenderness of the left lobe of the prostate.

Blood count showed white blood cells 7,400, red blood cells 3,200,000, hemoglobin 75 per cent, Wassermann reaction was negative. The urine was grossly bloody. X-ray examination of his chest was negative.

The day following admission to the hospital cystoscopic examination showed a fungating ulcerated lesion with a greyish green bleeding surface about the size of a half dollar situated in the dome of the bladder and surrounded by a border of induration. The remaining mucosa and the ureteral orifices were normal in appearance. The bladder outlet was obstructed somewhat by a small median bar formation. A diagnosis of carcinoma of the bladder seemed logical and surgical removal was advised.

On April 17, under nitrous-oxide-oxygen anesthesia the tumor surrounded by a margin of normal mucosa was resected. Since the induration extended upward along the urachus this structure together with the umbilicus was removed. The bladder was closed over a large mushroom catheter.

*Pathological report:* The excised specimen consisted of the fundus of the bladder, the middle umbilical ligament and the false ligaments of the bladder with the separately excised umbilicus. The umbilicus showed no abnormality whatsoever although sections were taken for histological examination. The bladder specimen when examined from



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Fig. 3. Right foot July 24, 1929.

Fig. 4. Right foot August 3, 1929. Roentgenogram taken before operation.

a cellular appearing greyish white hard tissue with an overlying hemorrhagic and necrotic surface. External to the bladder musculature there were numerous areas from 1 to 11 millimeters in diameter which showed a greyish yellow irregular border with softened necrotic centers.

The hardness of the entire specimen the proliferative ulceration of the mucosa the thickened mucosa with the greyish white streaks running through the muscularis and the large puckered necrotic mass of indurated fat external to the bladder musculature all simulated an infiltrating tumor of the bladder wall. The neoplastic appearance was further substantiated by the marked puckering of the peritoneal surface overlying the fundus of the bladder.

*Microscopic examination.* Sections taken to include various portions of the entire specimen revealed a wide spread inflammatory process characterized by areas of necrosis lymphoid plasma and epitheloid cell infiltration and the presence of giant cells (Fig. 4). The section which included the ulcerated mucosa showed an abrupt transition from slightly thickened and infiltrated bladder mucosa to an area of ulceration the base of which contained a formless necrotic debris with here and there well formed tubercles about the margin. The white bands described streaming through the muscularis in the gross proved histologically to be areas of fibrosis heavily infiltrated with lymphocytes plasma cells and in many instances they contained small tubercles. The necrotic areas external to the muscularis in the fatty tissue revealed small and large conglomerate tubercles with characteristic formless necrosis a heavy lymphoid infiltration marked epitheloid cell proliferation and very numerous giant cells. Sections

stained by appropriate methods revealed scattered acid fast rods which were morphologically typical of tubercle bacilli. There was no extension of the tuberculous process up into the middle umbilical ligament.

About 36 hours after operation the patient began to have difficult respirations and physical examination showed dullness over the right lower chest anteriorly with slight tubular breathing diminution of the breath sounds and reduced excursions. The X-ray diagnosis was massive collapse of the lung. This condition cleared up very slowly and for a number of days the patient had a severe productive cough with considerable pain over the right side of his chest. Repeated examination of his sputum failed to reveal tubercle bacilli and a chest tap was nonproductive. His wound healed rather slowly because of persistent urinary drainage due to the small size of his bladder. Twenty-eight days after operation his wound was completely healed and he was voiding small amounts of urine frequently.

From this time until his discharge from the hospital a month later his wound occasionally reopened and drained small amounts of urine for short periods of time. His chest cleared gradually and upon discharge still showed a mottling fibrosis of the right middle lobe anteriorly. On discharge the urine was clear sterile and showed no evidence of the tubercle bacillus.

October 27 1929. The patient reports that his health has been excellent since operation. He has gained weight. The function of the bladder is entirely normal and the urine is free from evidence of disease. He has had no further difficulty in regard to the lungs.



Fig. 1



Fig. 2



Fig. 3

Fig. 1 Peritoneal surface of bladder showing puckered and retracted central area which was opposite ulceration of the mucosa

Fig. 2 Mucosal surface of specimen showing irregular central ulceration

Fig. 3 Specimen opened by single longitudinal section from bladder mucosa upward into middle umbilical ligament. Note ulceration of bladder, partial replacement of musculature by puckering and retraction of peritoneum and necrotic areas in extravascular fat

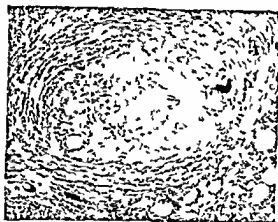


Fig. 4 Photomicrograph showing characteristic tubercle formation in bladder wall

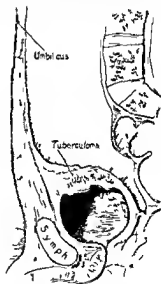


Fig. 5 A diagrammatic sketch illustrating the relationship and extent of the bladder tubercula

above downward was somewhat triangular in shape the apex of the triangle extending upward along the middle umbilical ligament toward the umbilicus. The external surface on this side of the specimen was covered over by peritoneum which in the mid portion or directly opposite the excised bladder mucosa showed a very extensively puckered central area (Fig. 1). This area measured approximately 2 centimeters in diameter and in addition to being hard and retracted was definitely injected over the peritoneal surface. The bladder or inner surface of the specimen was roughly circular in shape and measured 5 centimeters in diameter (Fig. 2). In the center of the excised mucosal surface there was an irregular ulceration of the mucosa which measured approximately 2 centimeters in diameter. This ulceration presented a hemorrhagic irregular and in part slightly undermined surface with a greyish yellow necrotic base and very little excavation. The deepest part of the ulceration was only 2 millimeters below the surface of the surrounding bladder. Be-

tween the mucosal and the peritoneal surface of the excised specimen the musculature of the bladder wall and the extravascular fat were included. A single longitudinal section was made directly through the ulceration carried through the bladder wall and extended upward into the center of the middle umbilical ligament (Fig. 3). The surface made by this incision revealed a markedly thickened bladder wall with small pinkish white irregular islands of what appeared to be smooth muscle tissue. These islands were separated by irregular varying sized bands of dense white tissue extending outward from the thickened and fibrous submucosa through the muscularis and into the adjacent fat. The ulceration on the cut surface showed

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Fig. 3. Specimen opened by single longitudinal section from bladder mucosa upward into middle umbilical ligament. Note ulceration of bladder, partial replacement of musculature, puckering and retraction of peritoneum and necrotic areas in extravesical fat.

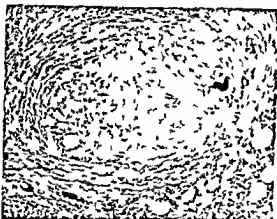


Fig. 4. Photomicrograph showing characteristic tubercle formation in bladder wall.

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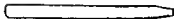


Fig 1 Steel die used in cutting out islands

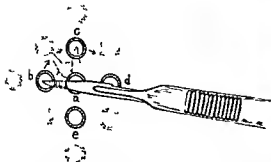


Fig 2 Illustrating method of undercutting skin between islands. Dotted portions and arrows indicate successive positions of scalpel

penses The foil pattern is placed upon the donor site of skin. The scalpel follows its periphery as it cuts through the skin just to the fat. A steel die resembling a cork borer or punch but having certain important differences well described in the accompanying drawing (Fig 1) is used. With a twisting motion of the thumb and index finger this die bores out islands of skin at equal distances from one another throughout the area of the graft. The cutting edge of the die measures one fourth of an inch in diameter and its flange is one sixteenth of an inch deep.<sup>1</sup> While each island is being bored out it is helpful to hold the surrounding skin under tension. This is accomplished by placing the index finger of the left hand to the right of the punch, the middle finger to its left and then pulling the skin apart with them while rotating the skin in a direction counter to that of the punch. The openings are made 1.5 centimeters apart. The next step is the most difficult one. A sharp pointed narrow bladed scalpel is necessary for its accomplishment. As shown in Figure 2, the point is pushed into the incision made by the punch for each island *a* keeping just the full thickness of the skin until its point comes out through the punch incision to the left of it but over the top of the corresponding island, *b*. With a sawing motion it is advanced to islands, *c* and *d* the skin surrounding which is similarly undercut. The blade is then reversed and the 180 degrees of the circle from *b* by *e* to *d* is completed in the same manner. As the scalpel enters each circular punch incision, an



Fig 3 Typical sieve graft covering entire popliteal space

assistant slightly depresses each island with a knife handle or other suitable instrument in order to prevent its injury. When each of the openings has been similarly undermined it is only necessary for one to undermine the peripheral edges of the graft in the usual manner and to cut through a few strands of overlooked tissue before the entire perforated or sieve graft will be freed. Thus having been obtained, the donor site will be found still to contain small islands of skin equally spaced within the fat and fascia. The dressing for it is a simple one—vaseline gauze covered with dry gauze strapped firmly with adhesive.

All fat is then removed from the graft with curved scissors and it is sutured into the wound with interrupted stitches of silk worm gut or horse hair. The approximation of the edges must be very accurate and if any depressions exist in the ulcer it must be sewed into them. For dressing the grafted area Blair's sea sponge technique is generally employed. The graft is pressed into contact in order to express all serum and blood clot. It is then covered with a layer of xeroform vaseline gauze mesh or ordinary vaseline gauze wiped until very little vaseline remains upon it. Then four layers of dry flat gauze are surmounted by very large, flat sea sponges which have been sterilized in bichloride and wrung out in dry towels just before using. Large sponges are necessary. One sponge if possible should cover the entire graft and extend well over the suture lines. Thus even pressure will be exerted. If only a portion of the wound has been grafted, the other part may safely be treated by the Carrel technique 48 hours later without fear of injury to the graft.

It is our practice to remove the sponge only after 10 days, provided infection is not indicated by local signs or fever. At this time we inspect the graft, remove stitches, trim away any necrotic

<sup>1</sup>Dies may be obtained at small cost from M. Herblin 2104 Dixie Place Nashville Tennessee

## THE SIEVE GRAFT—A STABLE TRANSPLANT FOR COVERING LARGE SKIN DEFECTS

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THE recent work of Blair on the full thickness skin graft and of Blair and Brown on large split grafts has demonstrated the feasibility of attempting transplants of dimensions larger than heretofore employed. Surgeons proficient in plastic work are now encouraged to undertake to cover defects at one stage which formerly would have required several.

With the increasing interest in the use of grafts of large size it is more than ever necessary to stress the factors contributing to the safety of grafting because if a graft fails, the patient's loss is in a way proportional to the size of the graft.

A new method of skin transplantation which we first devised and used in May 1928 has, we believe, greatly increased the safety of the use of large grafts. This has been called the "sieve" graft method because the graft is uniformly perforated with small round openings. A year's experience with this method has convinced us of its worth.

In general the safety of skin grafting depends on (1) attention to constitutional disease, (2) attention to local infection in the wound and (3) attention at operation and afterward to mechanical details.

The nature of the sieve graft especially satisfies the third condition because it provides for constant drainage over the entire surface. It also offers a better opportunity to overcome any post-operative wound infection. In this respect the sieve graft is as satisfactory as the small deep graft.

### HISTORICAL

In none of the original articles of Wolfe or Krause on skin grafts does one find any reference to the advisability of perforating grafts for purposes of drainage. Vogel and Foersterling first suggested perforating Thiersch grafts in 1917. In most of the articles of later date, notably those of Blair, Brown and Blair, and in Davis's text on plastic surgery, one does find the suggestion that full thickness grafts be perforated. In Davis's text there is a photograph of a saddler's punch with which he advises that perforations should be made "to allow the escape of any blood or secretions which may collect." Most authors are agreed that small holes "insure drainage of blood and serum." The work herein described demon-

strates the practical value of combining several operative steps in one. In a single step, adequate drainage openings are cut throughout the entire graft and enough islands of uninjured skin are left behind to insure healing of the donor site. In leaving behind enough skin to grow out and close the donor site, the sieve graft resembles the small deep graft of which it is the negative image (if we regard granulations as the black part and skin as the white part of the picture). At the end of the operation, however, more skin will have been transferred to the area which has most needed it than the latter type of graft could afford.

### INDICATIONS FOR THE USE OF THE SIEVE GRAFT

The sieve method will provide firm, safe healing without contracture in a defect upon any portion of the body. The cosmetic result accomplished is very nearly as good as that obtained by the Wolfe-Krause graft and it may, therefore, prove valuable in the future for plastic work upon the face.

### TECHNIQUE

The wound to be grafted is prepared before and at operation in the same manner as that described by Blair for the full thickness graft. (1) A pattern is outlined on transparent cellophane with a pen before the day of operation. This is made about one fourth larger than the wound. It is transferred to tinfoil and a single letter "E" is punched near the lower border for easy orientation. At operation the usual iodine alcohol or picric acid alcohol preparation is made. General anesthesia is usually employed but local anesthesia lends itself readily if there be any special reason for its use. Usually four lines of intradermal infiltration enclosing the pattern augmented by injection of 3 cubic centimeters subcutaneously at eight points equally spaced within the area to be lifted will suffice. At times where small varicose venules are present a more massive infiltration will be necessary.

The technique by which the sieve graft is removed is not difficult after the practice of one or two sittings. It does not require a longer time than an ordinary full thickness graft provided one includes the closure of the wound of excision with which closure the sieve method entirely dis-



Fig 5 Contracture from burn illustrating maximum extension possible before operation and healed result 60 days after first operation. Sieve graft is visible in popliteal region. Contracture relieved.

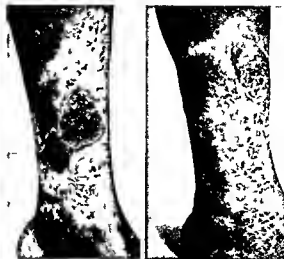


Fig 6 Chronic leg ulcer before operation and after application of sieve graft.

never stable. The ulcer measured 15 by 5 centimeters in center of scar about 22 by 8 centimeters. Preliminary treatment consisted in excision of the varix of the left saphenous vein and of the ulcer with surrounding and underlying scar. March 16, 1929. Operative repair patterned full thickness sieve graft was applied to lower one half of wound. March 28, 1929. Small deep grafts were applied April 5, 1929 and April 15, 1929 to the remaining portions of the granulating area. Result: healing was complete May 12, 1929 and area has remained healed to present time. Patient is now going about his active pursuits as a farmer.

CASE 6. I. F. aged 42 years. The predisposing causes of the ulcer were obesity, syphilis, aortitis, hypertension and varicose veins of both legs. The immediate cause was a bilateral thrombophlebitis 22 years ago. An ulcer formed on the right leg 5 years ago and on the left leg 6 years ago. Both ulcers were excised by Dr. Howard King 6 years ago. The appearance on admission to the hospital is shown in Figure 7. Both legs showed marked brawny swelling. Two punched out ulcers were present on the right leg about 5 centimeters above the ankle, one 6 by 6 centimeters, the other 4 by 5 centimeters. Two small ulcers were present on the medial surface of the left leg about 3 centimeters above the ankle, the first about 3 by 4 centimeters and the second 2 by 3 centimeters in size. Preliminary treatment consisted in antiseptic course, bilateral excision of saphenous varices and of scarred tissues surrounding and underlying ulcers by Dr. Alfred Blalock. March 22, 1929. Under local anesthesia, full thickness patterned sieve graft was applied to the granulating area of the left ankle. April 17, 1929. A similar graft was applied to the right leg. April 30, 1929. Grafts were taken except for one or two narrow areas at the edge of the second which were grafted with small deep grafts. Areas were practically healed on June 6, 1929 as shown in photograph. While this patient is a very recent one, results in previous cases indicate that healing will be stable (Fig. 7).

<sup>1</sup>Grateful acknowledgment is hereby made to the men whose names are mentioned in this work as due to each of the men whose names are mentioned.

The ideal graft for filling in large skin defects must possess the following properties:

1. It must be capable of being so cut that its removal will leave behind a wound which will heal rapidly without further grafting and with only slight scarring.

2. It must be able to take hold and grow upon a moderately infected surface.

3. It must provide complete healing in a reasonably short time.

4. It must inhibit scar formation and subsequent contracture—a point especially important in defects over joints.

5. It must produce a skin surface so pliable that healing is stable and resistant to minor injuries.

6. It must effect a good, though not necessarily an excellent, cosmetic result.

Weighing each of the types of grafts in general on the basis of these points, our experience is as follows:

1. The Ollier-Thiersch graft fails from the standpoint of resisting infection and of preventing contracture, and the surface healed by its employment is easily eroded.

2. The small deep graft is ideal from every standpoint but two, viz: it fails to prevent contracture and often fails to give a good cosmetic effect.

3. The Wolfe-Krause or full thickness grafts are excellent from the standpoints of stable healing, cosmetic effect, and prevention of contracture. However, if the graft is large, a defect is left behind at the donor site which will require



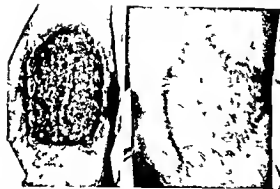


Fig 4 Typical appearance of donor site in early and late stages. The early stage shows islands left behind in removing graft. The late stage shows that the islands have furnished pigmented skin for the entire area.

portions, and reapply the pressure dressings. Within 12 to 18 days the perforations will usually be found entirely epithelialized and the pressure may be discontinued.

The islands for reasons now being verified experimentally will require a slightly longer time than this period to accomplish healing of the donor site, but their healing will be found to proceed with absolute certainty and a pigmented epithelium will result. These islands have the appearance of small deep grafts but are not to be confused with them. In reality, since they have not been undercut they are fortresses of strength. The epithelium from them has great healing power. One need not undermine the edges of the wound nor otherwise attempt closure. In every case the wounds have healed uneventfully and with almost full pigmentation.

In order that the reader may be able to form an adequate estimate of the safety of this graft and of results obtained through its use we give brief abstracts describing the course to date of every case in which it has been employed.

#### ABBREVIATED ABSTRACTS OF SIX CASE RECORDS

CASE 1. W. K. aged 8 years suffered a burn of the left thigh and popliteal space in January 1918. An ulcer measuring 12 by 7 centimeters persisted near the popliteal space for 11 months and resulted in a scar which caused extreme flexion contracture of the knee. Treatment consisted in excision of the scar, tendon lengthening by Dr. R. W. Bilington, extension of knee and two-stage grafting. First a full thickness patterned sieve graft was applied to the flexible portion of the wound at the crease of the popliteal space, second small deep or Davis grafts were applied above and below the first graft. Result healing with good function in 90 days after entering the hospital. Walking with 170 degrees of extension after 2 months. No recurrence. (See Figure 5.)

CASE 2. P. B. aged 48 years suffered a burn of the left thigh, perineum and popliteal space in 1910. Ulcers of

thigh and popliteal space persisted for 18 years. The ulcers and accompanying scar caused extreme flexion contracture of left knee and were excised at Nashville General Hospital in 1918. No grafting was done. Patient was admitted to the Vanderbilt Hospital February 25 1918. Multiple ulcers were present from posterior fold of left buttock to middle third of leg. The largest ulcer was in the popliteal space and measured 7 by 11 centimeters; the edges were indurated and hard. Diagnosis: epitheliomatous degeneration of ulcer in cicatrix of burn or so-called Marjolin ulcer. Diagnosis was confirmed by biopsy. Preliminary treatment consisted in complete excision by wide margin of ulcer bearing area. Operative repair first stage a full thickness patterned sieve graft was applied to the entire popliteal space (Fig 3) second stage small deep grafts from abdomen were applied to area above the sieve graft and third stage small deep grafts from abdomen were applied to area below the first graft. Healing was complete 55 days after excision of the ulcer. Area remained healed for 2 months since which time he has had a local recurrence of the cancerous lesion in the form of a warty growth which he has refused to have treated. In the 9 months which have followed this growth has increased in size from 0.5 centimeters to 3 centimeters in diameter. The remaining portions of the wound have remained solidly healed and the patient has been able to earn full wages as a stoker of furnaces.

CASE 3. A. M. aged 59 years had had varicose veins for 10 years. These were treated by ligation 17 years ago. Varicose ulcers had been present on the outer surface of the left leg in the middle third for 14 years. When patient entered the hospital several shallow ulcers were noted in the middle third of the leg. Preliminary treatment consisted in wide and deep excision of ulcer bearing area including scar. Operative repair first stage a patterned full thickness sieve graft from the thigh was transplanted to the lower half of the wound, second stage small deep grafts were applied to the remaining upper portion of wound. Healing was very slow. Patient was sent home with an Unna paste bandage. Area was entirely healed and dry dressing was applied 4½ months after operation. Patient is doing well wearing an elastic stocking although the swelling of the extremities and high blood pressure continue. The leg has shown a slight superficial ulceration during the present week or 2 months after complete healing.

CASE 4. J. B. aged 57 years. The predisposing cause of ulcer was arteriosclerosis with extreme hypertension. The immediate cause was a wound of the leg at the ankle 2 years before admission to the hospital with evidence of local thrombophlebitis. The ulcer measured about 9 by 5 centimeters. In the center was a large area of white scar above the left internal malleolus. Preliminary treatment consisted in per arterial femoral sympathectomy by Dr. George Johnson followed 9 days later by deep and wide excision of the scarred area including the ulcer. Dr. Barney Brooks who performed the second operation swung a flap of good skin up over the tibial crest which had necessarily been exposed during the dissection. Operative repair full thickness sieve grafts were fitted to the remaining portions of the wound in two stages. Grafts were complete takes but stitch lines along back of the leg broke down slightly and required a few small deep grafts on August 6. Healing was not complete until January 14 1919 or 8½ months after the excision. Since then for 10 months healing has been solid (Fig 6).

CASE 5. W. R. aged 40 years. The predisposing factors were moderate arteriosclerosis with hypertension, varicose veins of indefinite duration, certainly more than 10 years, an injury at site of ulcer 20 years before admission, healing

- 7 The grafts averaged 110 square centimeters per operation
- 8 Five of the 6 patients had skin applied to ulcers extending over joints
- 9 Results in all cases have been satisfactory

#### CONCLUSION

The sieve graft provides a safe and useful means of closing large defects in the skin

#### BIBLIOGRAPHY

- 1 BLAIR V P Ann Surg 1924 lxxv 298
- 2 BLAIR and BROWN Surg Gynec & Obst 1929 xlix 82
- 3 DAVIS J S Plastic Surgery Philadelphia P Blakiston & Son and Co., 1919
- 4 KRALSE Verhandl der deutsch Gesellsch f Chir 1893 xiii
- 5 VOGEL and FOERSTERLING Quoted by Davis loc cit p 78
- 6 WOLFE Brit M J 1875 September p 360
- 7 Idem Glasgow M J 1876 April

## PSEUDOMYXOMA PERITONÆI ORIGINATING FROM MUCOCELE OF THE APPENDIX<sup>1</sup>

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**C**YSTIC dilatation of the appendix, although relatively rare, may be the precursor of the pathological entity known as pseudomyxoma peritonæi. In this condition of the peritoneum, masses of gelatinous pseudomucinous or mucinous material are distributed over the surface, either as a homogeneous layer or as multiple cystic masses. Pseudomyxoma peritonæi is most often seen in women and is usually associated with a ruptured pseudomucinous cystadenoma of the ovary. It is also found in both men and women following rupture of a mucocele of the appendix. Werth is credited with coining the term pseudomyxoma peritonæi in 1884 because the gelatinous masses which he found over the peritoneum in a case of ruptured ovarian pseudomucinous cystadenoma was proved by Hammarsten to be of pseudomucin instead of mucin. He thought the peritoneum underwent myxomatous degeneration. Fraenkel in 1901, first reported the condition in the male. In his case it had followed rupture of a mucocele of the appendix. He retained the term pseudomyxoma peritonæi because of the gross similarity of the gelatinous exudate to that found in the cases previously reported, under the same name in women. Ols hausen probably gave the first correct idea as to the means by which this condition originates. He believed that epithelial cells from the lining of the ruptured cyst were transplanted to the peritoneum, that there they took root and continued to secrete the gelatinous material.

Cystic dilatation of the appendix may take the form of true hydrops in 0.9 per cent of all cases according to Dodge. More commonly, it takes the form of mucocele. Norment mentioned that Fere was the first to apply the term, retention cyst, hydrops, or mucocele, to that portion of the appendix in which dilatation had occurred. The condition was first recognized by Virchow, and he considered his case as one of colloid degeneration of the appendix. Elbe on the basis of examination at necropsy, reported the incidence of cystic appendices to be 0.5 per cent, and on the basis of examination of surgically removed appendices 0.7 per cent. Corning reported that 0.54 per cent of surgically removed appendices are cystic, Kelly and Hurdon gave 0.42 per cent, and Ribbert, a little more than 1 per cent. Castle reported from the literature a frequency of 0.2 per cent of mucocele of the appendix in 13,158 necropsies. Dodge, in 1916, also made a careful review of the literature and was able to find only 147 cases. In Norment's study of 45,000 appendices surgically removed at The Mayo Clinic, 36 cysts were found. The average age of patients in these 45,000 cases was 41 years. The youngest patient was 4 years of age, the oldest patient was 65 years of age. Sixty-one per cent were in males.

It is commonly thought that before a mucocele of the appendix can occur, there must be some point of obliteration or obstruction of the lumen of the appendix. Probably the most important factor in the production of such obliteration of a



Fig 7 Old varicose leg ulcers showing condition before operation, after wide and deep excision, and the healed result following sieve grafting. Perforations have rapidly epithelized.

further grafting—a distinct disadvantage. Furthermore, infection may readily cause its total loss.

The sieve graft satisfies all of the demands enumerated. Two valuable properties possessed by none of the above varieties deserve especial mention: (1) the perforations, by providing adequate drainage, make it resistant to infection, thus insuring a very high percentage of takes; (2) the donor site requires no further grafting and heals with a good cosmetic result.

Regarding our 6 cases as illustrative, we see that it has been used on very extensive wounds after a preliminary debridement and treatment of constitutional disease had made surgical repair possible. From photographs and actual tracings the 8 grafts used on the 6 patients measured approximately 32, 129, 116, 77, 103, 77, 67, and 225 square centimeters respectively, or an average of 110 square centimeters to a graft. The fourth and sixth patients had two grafts each. At least 90 per cent of each grafted surface has taken infection in 2 cases notwithstanding. Of the 6 patients, 1 had a history of a burn, another a burn with an epithelioma in the scar, 3 others varicose veins, 2 of them complicated by arteriosclerosis, and 1 by syphilis. In the sixth, or Case 4, an injury had caused an ulcer upon a leg in which the vessels were already sclerosed.

With such patients the healing process even after appropriate constitutional and local measures has the odds against it. It is noteworthy that each of the 6 patients have been followed carefully through the efforts of the Social Service and

the results have been such that every one of them has been able to get on his feet again and pursue his routine duties. While there have been a few small superficial excoriations at the suture lines, there have never been any within the confines of the graft proper. The only ulceration came 2 months after complete healing (Case 2) and in this instance was due to a local recurrence of an epithelioma.

Figure 7c shows that the perforations heal so quickly that the resulting scar is negligible, yet the very skin left behind by punching them has served to heal the donor site completely and with pigmented epithelium (Figure 4b).

#### SUMMARY

1. Increasing experience with skin grafts of large size makes it imperative to study the factors contributing to the safety of grafting.

2. An original method is described for obtaining a new type of full thickness graft which has been named the sieve graft because of its uniform perforation with round openings.

3. In this method the excision of the transplant and the potential closure of the donor site is provided for in one operative step.

4. Through its use a large area of skin may be transplanted in a single piece while perforations provide constant drainage of its entire extent.

5. Infection is overcome and the safety of the graft greatly enhanced by adequate drainage.

6. Results are shown through the histories of 6 consecutive cases which received a total of eight transplants of this kind.

marsten's method for chemical analysis of the gelatinous contents of two mucocèles and found them to be pseudomucin. Phemister also reported a reaction of pseudomucin.

A paper was published recently by Naeslund on the experimental production of pseudomyxoma peritonæi. He ligated the appendix in newly born rabbits about 1.5 centimeters from the tip and then cut across the appendix just distal to the ligature. The distal stump was left open and the vascular supply through the meso-appendix was not disturbed. In most of the animals little mucous cysts developed between the cut stumps of the appendix. Part of them burst, and mucous material spread over the peritoneum. In some animals small cysts about 1 centimeter in diameter filled with mucus developed in the mesentery, intestines, and peritoneum. The little cystic nodules were covered with epithelium. At times cylindrical mucosal epithelium would grow into the serosa of the bowel and into the wall of the bowel forming nests of this epithelium in glandular or cellular arrangement, within the sacs were collection of mucus. He found experimental and clinical conditions to be similar. Phemister was unable to produce cysts by artificial ligation of the appendices of dogs.

The prognosis of pseudomyxoma peritonæi resulting from mucocèle of the appendix is much more favorable than of that which arises from pseudomucinous cystadenoma of the ovaries. Seelig outlined four possible courses of events following the escape of pseudomucin from the cystic appendix: (1) the exudate may be limited in its escape, to the right iliac fossa; in such cases, firm adhesions establish themselves forming a connective tissue capsule; (2) the exudate may escape to various and multiple intraperitoneal sites, sometimes, in this form, the material may become delicately encapsulated and may hang from the intestinal peritoneum as little polyps; (3) it is possible for the exudate to be absorbed entirely; and (4) there may be wide dissemination of the exudate with a tendency to marked secretory activity on part of disseminated material. There is accompanying adhesive peritonitis.

Several authors have reported pseudomyxoma peritonæi associated both with pseudomucinous cystadenoma of the ovary and with mucocèle of the appendix. In such cases, the cystadenoma or the mucocèle or both, may be found to be ruptured (Figs. 1 to 7).

#### REPORT OF CASES

In the following six cases of pseudomyxoma peritonæi the origin was the appendix. Five of



Fig. 3. Lining of mucocèle showing columnar epithelium.

the patients were women, one patient was a man. The average age was 57 years. The youngest patient was aged 37 years and the oldest, 69 years.

**CASE 1.** A woman, aged 50 years, had had an attack of appendicitis 26 years before she was seen at the clinic. During June and July, 1921, she had reported attacks of nausea, vomiting, pyrexia, and pain in the right lower quadrant of the abdomen. In August an appendiceal abscess was drained, and she was advised to undergo appendectomy sometime later. She returned to the clinic for this operation in April, 1922.

A mucocèle involved the tip of the cecum and the surrounding peritoneum. All the diseased tissue was dissected out and removed. Free mucoid material was not found scattered over the peritoneal cavity, although there was some in close proximity to the appendix opposite a perforation 1.5 centimeters from the base. There was no evidence of involvement of the uterus and ovaries.

The patient is living without symptoms 6 years and 6 months after operation.

**CASE 2.** A woman aged 69 years gave a definite history of disease of the gall bladder extending back 4 years or more from the time when she came to the clinic. General examination revealed a small umbilical hernia and the questionable presence of a fluid wave in the abdomen. Roentgenographic examination of the thorax gave evidence of tuberculosis, probably not active in the apices of both lungs.

Cholecystectomy for gall stones was done April 21, 1920. At the time of this operation a large amount of gelatinous material, which was thought to have its origin in the pelvis, was found in the abdomen. Much of this material was removed. Three weeks later abdominal hysterectomy



Fig. 1. left. Large mucocoele of appendix dark areas where rupture is almost ready to occur are shown



Fig. 2. Mucocoele of appendix apparently developing in diverticulum

portion of the lumen is an old or recent inflammation of the appendix which has regressed. Other factors which may act in a similar manner are kinking of the appendix, adhesions around the appendix, or a malignant condition of the appendix. One case was reported in which a polyp was thought to be the factor in producing the obstruction resulting in the formation of a mucocoele. However, Dodge mentioned 5 cases of mucocoele in which the appendiceal lumen was said to be patent. *Diverticulum of the appendix* with constriction of the proximal portion of the lumen may be another etiological source for the formation of the mucocoele. MacCarty and McGrath found diverticula in 17 of 5,000 appendices examined. Moschowitz found the condition in 4 of 1,500 appendices. Gardham, Choyce and Randall are of the opinion that such diverticula frequently lead to pseudomyxoma peritonei.

Mucocoeles of the appendix may be sausage-shaped, banana shaped, fusiform or globular and may vary in size from about 15 centimeters in diameter to 3 centimeters or less in length. In cases in which the epithelial lining of the cysts can

be distinguished it is made up of the columnar or cuboid type of cell. The walls of the cysts may be thick and may contain varying proportions of the different coats of the appendix. On the other hand they may be as thin as tissue paper, and there may be saccular formations in them. The absence of infective organisms from the involved portion of the lumen is considered a necessary condition for cystic development. Mucocoele may be found in any situation in the abdominal cavity in which it is possible for the appendix to be. A few appendiceal mucocoeles reported in the literature have been in hernial sacs and within the inguinal canal.

Authors differ as to the identity of the gelatinous content of the mucocoele. Dodge in his review mentioned that chemical examination of the contents was made in 6 cases. In 3 the reaction was that of mucin, in 2 of pseudomucin and in 1 case of colloid. Trotter stated that the microchemical reaction is that of mucin. Castle mentioned that careful chemical analysis of the content of mucocoele of the appendix proved it to be pseudomucin. Norment in his study used Ham



Fig 5

Fig 5 4 large mucocoele of the appendix a small plug was removed for microscopic examination



Fig 6

Fig 6 Mucocoele near the tip of an appendix

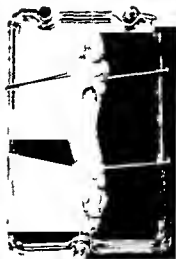


Fig 7

Fig 7 Multiple diverticula of appendix

a mass which could be felt by both abdominal and pelvic examination

At abdominal exploration June 21 1920 appendectomy for colloid carcinoma of the appendix was done There were multiple regions of metastasis in the mesentery of the small intestine and in the omentum The appendix and a large mass of colloid material was removed from the right iliac fossa and several nodules of colloid material were removed from the omentum

Following operation the patient was given thorough courses of deep roentgen ray treatment When last heard from 8 years after operation she was in good health and had no knowledge of evidence of recurrence

In reviewing a series of cases in which unruptured mucocoele of the appendix had been found at operation it was notable that in several instances a mucocoele had developed following drainage of a ruptured appendix or of an appendiceal abscess In the first case reported in this paper a mucocoele had developed following drainage of an appendiceal abscess The mucocoele in turn had ruptured and had produced a localized form of pseudomyxoma peritonæi This series of events took place in the relatively short space of 9 months following drainage of the appendiceal abscess Before the mucocoele could form the local region must have become sterile as a result of the reaction of the tissues, helped by the drainage operation Undoubtedly, the appendiceal lumen was constricted at one or more points

by the scarring produced by the acute inflammation The probable course of events in this case may be described as follows A portion of the epithelial lining beyond a constriction had not been destroyed and continued its function of secreting mucus after the regression of the inflammation This, in turn, produced a cystic pocket of mucoid material, or a mucocoele As the cystic pocket expanded from the pressure of the secreting cells, rupture took place at some point of lowered resistance With the outpouring of the gelatinous content, some secreting epithelial cells may have been carried along with it These cells attached themselves to the peritoneum and continued to secrete gelatinous material

The condition known as pseudomyxoma peritonæi begins in the way described The reaction of the peritoneum to the gelatinous material varies Usually the peritoneal tissues react as they would to a foreign body, with the production of adhesions and walling off with connective tissue of the mucoid secretion

Also an attempt is made to absorb the foreign material Sometimes the reaction of the peritoneum appears to be passive, as in the third case reported An excellent prognosis may be given in such a case following removal of the offending lesion and mechanical scooping out of most of

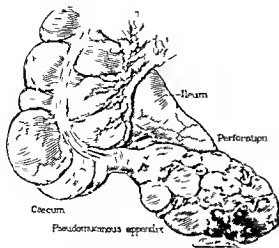


Fig. 4. Mucocele of appendix which had ruptured

together with bilateral salpingo-oophorectomy and appendectomy was performed. The entire peritoneum was congested and reddened and much colloid myxomatous material was present in the abdominal cavity. As much of this material as possible was removed. The ovaries were small and were the site of bilateral chronic oophoritis. The oviducts both of which were affected with chronic tuberculous contained much caseous material. In the appendix was a colloid carcinoma which had ruptured and which was the source of the myxomatous peritonitis.

The patient received several treatments by radium and roentgen ray and is living in fair health 4 years and 8 months after the last operation.

**CASE 3.** The mother and two aunts of a woman aged 61 years had died from carcinoma. The patient gave a history definitely typical of duodenal ulcer and extending back over several years. On general examination of the abdomen there was some generalized tenderness which was more marked over McBurney's point. Roentgenographic examination of the stomach gave evidence of the presence of a duodenal ulcer.

September 27, 1921: appendectomy and gastroduodenostomy were performed. About 2 liters of jelly like colloid myxomatous material was removed from the abdominal cavity. The appendix was filled with colloid material and was ruptured near its end. The organs of the entire abdomen were covered with the gelatinous material and as much of it as possible was scooped out. There did not appear to be any grafting of the gelatinous growth on the peritoneum. The mucoid material was simply in contact with it. The ovaries fallopian tubes and uterus were in good condition.

Treatment by roentgen ray was given after operation. The patient is now living 11 years after operation.

**CASE 4.** For 7 or 8 years a woman aged 61 years had felt as if she had a mass in the lower right quadrant of the abdomen. This had increased about three times in size during the 18 months before she came to the clinic and the increase had been associated with some tenderness and pain in the right groin. Also the right thigh had been swollen for 18 months. General examination revealed a smooth rounded cystic tumor occupying the right side of the abdomen and flank and extending within two fingers breadth of the right costal margin. There appeared to be

marked edema of the mesial portion of the right thigh but no noticeable edema of the ankles.

At operation June 5, 1917 the abdominal mass was found to be a large retroperitoneal gelatinous myxomatous tumor attached to the end of the appendix. When the mass was opened it was found to be filled with colloid myxomatous material and was divided into two compartments each of which contained about half a liter of this substance. The lower pocket extended down underneath Poupert ligament and bulged in the anterior portion of the thigh. These cavities were emptied of their contents and were wiped out as clean as possible. The appendix was removed. There was a mucocele at its tip which had perforated thus forming the gelatinous masses. Pelvic examination at the time of operation gave negative results. The patient was treated with radium introduced through a drainage tube.

The patient returned to the clinic 2½ years later with a tumor about 15 centimeters in diameter on the inner surface of the right thigh. The tumor had increased markedly in size during the previous 6 months. It extended midway to the knee and medially to the vulva. There was also an abdominal tumor extending from the right iliac fossa to the umbilicus.

February 20, 1920 the neoplasm on the thigh was opened and drained. It was found to have pockets which were filled with gelatinous material. This material apparently had worked its way downward from the abdominal growth and it probably had followed the psoas muscle. Three rubber tubes were put in for treatment by radium.

The patient was advised to have an abdominal operation later but this was not performed. She died in 1920 5 months after the last operation. The pathologist's report at the time of the second operation was pseudomucinous cystadenoma. Microscopic evidence of a malignant condition was not found. There was an interval of 10 to 11 years from the time of onset of symptoms to death and of 3 years and 4 months between the primary operation and death.

**CASE 5.** A man aged 37 years had noticed a gradual progressive swelling of the abdomen over a period of a year. He had undergone abdominal paracentesis on two occasions elsewhere during this time and each time about 3 liters of yellowish fluid containing flakes and strawy mucus had been removed. Early morning abdominal cramps was another of his symptoms. General examination revealed the abdomen to be distended to grade 2 and a fluid wave and shifting dullness were present.

Abdominal exploration was done October 23, 1922. The abdomen was completely filled with gelatinous material and fluid. There were cystic implantations on the mesentery, visceral peritoneum and liver. The omentum was markedly infiltrated and was about 10 centimeters in thickness. The surgeon considered the appendix to be the original source of the gelatinous ascites. The abdomen was closed after exploration. The pathologist's report of tissue removed from the region of the appendix was of mucinous cystadenoma of the appendix.

The patient was given several courses of deep roentgen ray treatment after operation. Some improvement of his condition was noted for several months but later the course was steadily downward and symptoms of intestinal obstruction appeared. The patient died April 29, 1923, 2½ years after operative diagnosis and 3½ years after the onset of symptoms.

**CASE 6.** A woman aged 64 years had been troubled for a year with soreness and pain in the right lower quadrant of the abdomen. The pain was sharp and colic like at times and on some occasions nausea and vomiting had been associated. Pyrexia had not appeared. General examination revealed in the right lower quadrant of the abdomen

much value. Secondary operations may be necessary for further removal of mucoid material and to give relief from obstructive phenomena. All but one of the patients whose cases are reported in this paper had treatment by roentgen ray or radium.

Old inflammation is a large factor in the production of mucocele of the appendix. Other factors are considered.

### BIBLIOGRAPHY

- 1 CASTLE O L. Cystic dilatation of the vermiform appendix. *Ann Surg* 1915 xli 582-583.
- 2 CORNING ERASTUS. Retention cyst and diverticulum of the vermiform appendix. *Albany M Ann* 1905 xvi 816-831.
- 3 DODGE G E. Cystic dilatation of the vermiform appendix. *Ann Surg* 1916 lxiu 334-348.
- 4 ELBE. Quoted by Seelig.
- 5 FRAENKEL E. Pseudomyxoma peritonei. *Muenchen med Wchnschr* 1901 lxviii 965-970.
- 6 GARDHAM A J, CHOICE C C and RA. DALL MARTIN. Diverticulosis of the appendix and pseudomyxoma peritonei. *Brit J Surg* 1928 xvi 62-68.
- 7 KELLY H A and HURDON E. *The Vermiform Appendix and Its Diseases*. Philadelphia W B Saunders Company 1903 pp 250-258.

- 8 MACCARTY W C and McGRATH B F. Clinical and pathological consideration of obliteration carcinoma and diverticulum of the appendix. *Surg Gynec. & Obst* 1911 xii 211-220.
- 9 MOSCHCOWITZ. Quoted by Gardham Choyce, and Randall.
- 10 NÄSBLUND JOHN. Zur Kenntnis des Pseudomyxoma peritonei et processus vermiformis. *Upsala Lakaref. Forh* 1928 xxxiv 1-219.
- 11 NORMENT W B. Tumors of the appendix. (Unpublished data).
- 12 OLSHAUSEN R. Ueber Metastasenbildung bei gutartigen Ovarialkystomen. *Ztschr f Geburtsh u Gynaek* 1884 xi 238-245.
- 13 PHEMISTER D B. Pseudomucinous cyst of the appendix: its relation to pseudomyxoma peritonei. *J Am M Ass* 1915 lxiiv 1834-1836.
- 14 RIBBERT. Beiträge zur normalen und pathologischen Anatomie des Wurmfortsatzes. *Arch f path Anat* 1893 cxxxi 66-90.
- 15 SEELIG M G. Pseudomyxoma peritonei in male subjects. *Surg Gynec & Obst* 1920 xxx 570.
- 16 TROTTER W. Peritoneal pseudo myxoma originating from the vermiform appendix. *Brit M J* 1910 i 637-689.
- 17 VIRCHOW. Quoted by Norment.
- 18 WERTH. Klinische und anatomische Untersuchungen zur Lehre von den Bauchgeschwulsten und der Laparatomie II. Pseudomyxoma peritonei. *Arch f Gynaek* 1884 cxlii 100-118.

## CONSTANT VACUUM ASPIRATION TREATMENT OF EMPYEMA

### A SIMPLE DEVICE IN CREATING VACUUM

EDWARD E MANSUR M D JEFFERSON CITY MISSOURI

**T**HOUGH empyema has been one of the earliest conditions falling within the realm of surgery, few changes and improvements have been published. Its treatment by one or the other of the accepted methods has given results apparently good enough to satisfy the average surgeon.

Empyema is such a frequent sequela of pneumonia and pulmonary injuries that it has its quota of patients in all general hospitals. During the peak of respiratory troubles, especially of the streptococcus type, it will be found well up in front, in point of numbers of cases in the surgical wards. The goal desired in the treatment of this affection must be the restoration of the patient's partially collapsed lung back against the parietal chest wall as in the normal.

The surgical attack may be divided into two methods: the closed method in which repeated aspiration of the pus is done, and the open method or direct drainage, in which an opening through the chest wall is made and for a time maintained with or without rib resection.

Many years ago attention was called to the fact that creation of a moderate degree of vacuum between the chest wall and the collapsed lung was a thing to be desired. Elaborate hydrostatic suction apparatus was devised and used. It was soon found that this apparatus cluttered up the patient's room and his bed, restricted the patient's movements and required much supervision. Mechanical devices were built and found to require too much supervision. These measures were never popular, not because the creation of intrathoracic vacuum failed to give excellent results, but because the known means of applying this method to the patient was coupled with so much apparatus and supervision.

If a large group of postoperative cases, in which the patients have been treated by simple drainage in the usual way, without vacuum, are studied, it will be found that many of these chests show a permanently crippled lung. This may be seen in the radiogram if not in the postmortem examination. Fibrous tissue, dipping far into the



SUMMARY OF CASES OF PSEUDOMYXOMA  
PERITONÆI OF APPENDICEAL ORIGIN

Case	Age years	Sex	Type of disease	Comment
1	50	F	Localized in right iliac fossa	Living without symptoms of recurrence 6 years and 6 months after operation
2	67	F	Generalized pseudomyxoma peritonæi with colloid carcinoma of appendix associated with tuberculosis of fallopian tubes	Living in fair health 4 years and 8 months after operation
3	61	F	Generalized pseudomyxoma peritonæi passive reaction of the peritonæum	Living apparently without recurrence of symptoms 12 years after operation
4	61	F	Retropitoneal origin in appendix with extension to peritoneum and thigh	Died 3 years and 6 months after operation and 10 to 12 years after onset of symptoms
5	37	M	Generalized pseudomyxoma peritonæi	Died 2 years and 4 months after operation
6	64	F	Generalized colloid reaction of peritoneum colloid carcinoma of appendix	Living apparently without symptoms of recurrence 8 years after operation

the gelatinous material. In spite of the inherent resistance of the organism helped by surgical procedures, some of these cases of pseudomyxoma peritonæi progress and death results. This can take place although microscopic evidence of a malignant condition cannot be found in the regions involved, as in the cases of the two patients in this series who died from the disease. Most likely deaths under such circumstances are due to pressure and adhesions associated with the pseudomucinous abdominal masses. Intestinal obstruction and dysfunction of the different viscera are potent factors in the outcome. If a malignant condition is present, its influence on the course of the disease is similar to that of a malignant growth anywhere. However a neoplasm in the appendix is of a slow growing, low grade type.

It might be mentioned that in 3 of the patients whose cases are reported here, the number of leucocytes was 14 000 to 16 000 in each cubic millimeter. An explanation of this is not afforded unless it lies in the fact that the hematopoietic system was stimulated by the low grade inflammatory reaction which takes place in the peritoneum as a result of the presence of the gelatinous material. Hemoglobin varied from 67 to 78 per cent. Although some of our patients reported definite, gradual enlargement of the abdomen, all lost from 6 to 19 pounds in weight.

Mucocoeles of the appendix are found more frequently in males than in females. Nevertheless

strange as it may seem only 1 of our 6 patients with pseudomyxoma peritonæi of appendiceal origin was a man. In none of the 5 women were the ovaries involved with pseudomucinous cystadenoma. Also, pseudomyxoma peritonæi of appendiceal origin is mentioned in the literature as being most frequently confined to the pelvis. Nevertheless in only one of the cases reported was the disorder limited to the pelvis. The tabulation gives a summary of the length of life of the patients since operation. All but one of them received treatment by either roentgen ray or radium. Two of them have died, and in each of these two cases the course was progressively downward. Those who are living have no knowledge of evidence of recurrence of pseudomyxoma peritonæi.

The treatment in these cases is mainly surgical. This treatment is followed by either radium or roentgen ray. Removal of the appendix with the mucocoele is most urgent. Also, removal of as much of the gelatinous material as possible is worth while. Treatment by radium or roentgen ray after operation appears to be of value in these cases, especially if a malignant condition is present. However a favorable reaction cannot always be expected. Secondary operation may be necessary for further removal of mucoid material which has collected or to overcome obstructive phenomena.

## SUMMARY

Six cases of pseudomyxoma peritonæi of appendiceal origin are reviewed. One of these cases was in a man and 5 were in women. The ovaries were not involved with pseudomucinous cystadenoma. The average age of the patients was 57 years. Two of the patients had colloid carcinoma of the appendix. There was no operative mortality.

Two of the patients have died from the disease in periods of 2½ to 3 years after operation. In one of these patients the onset of symptoms was 10 to 11 years before death and in the other, 3½ years. The 4 other patients are living from 4 years and 8 months to 12 years after operation and have no knowledge of evidence of recurrence of pseudomyxoma peritonæi. In one case of the series the condition was unusual in that there was extension of the gelatinous material into the thigh.

Prognosis in pseudomyxoma peritonæi of appendiceal origin seems to be better than in that of ovarian origin. The reaction of the peritoneum varies in different persons.

The treatment is surgical removal of the appendix and of the mucocoele together with as much of the gelatinous material as possible. Treatment by roentgen ray after operation may prove of



Fig. 1

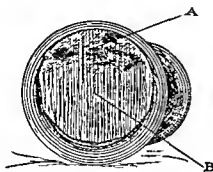
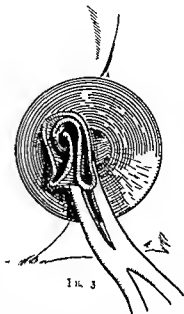


Fig. 2

Fig. 1 Wilson drainage tube  
 Fig. 2 Note sheet rubber attached to larger (external) face of tube  
 Fig. 3 Flange held by forcep to facilitate introduction



have just battled a pneumonia or whatever the exciting cause of their empyema may have been. In the border line cases it is confidently believed that the use of this technique will save many who would otherwise be lost.

A more dependable lung expansion, a minimum of scar tissue and a much shortened convalescence should be looked forward to.

#### CONCLUSIONS

The value of constant suction creating a small definite constant intrathoracic vacuum in treat-

ing empyema, seems based upon sound reasoning. When such a vacuum can be created and maintained so easily, by such a method as has been herein described, its use should become more general.

If the end results of treatment leave a patient with a chronic pleural cavity or dense adhesions extending from the outer chest wall to the lung root, a good functional aeration of that lung may not result.

A simple practical means seems now available for the treatment of double empyema.

lung toward the hilus is present. General, and at times great, thickening of the pleura of the affected side is seen. These abnormal states cause limitation of expansion of the affected lung, even diaphragmatic excursion may be limited. Such adhesions, if quite dense, may hold the lung as in a vise.

Comparison of cases treated by the usual open drainage method with cases treated by auto vacuum has, in the author's cases, reduced these abnormal results to the minimum. Where cases of double empyema are encountered, such a method as herein described, offers a happy way out of what would otherwise be a trying situation.

A Wilson<sup>1</sup> drainage tube (Fig. 1) is prepared in the following manner. Over its external face (the larger flange side, Fig. 2) is placed a sheet of rubber. Rubber dam material as used by dentists is excellent for this purpose. This small sheet of rubber is attached on one side only (Fig. 3 A). The method of attachment may be by a little rubber cement or by a safety pin. This simple procedure makes a one way valve trap, which, when placed in the chest wall will be found to offer no hindrance to the escape of pus and air from the empyemic cavity but will allow nothing to re enter it. The tube, prepared as above is now further prepared just before introduction into the chest wall by having its smaller flange side rolled up and held by a haemostat (Fig. 3) to facilitate its easy introduction into a small chest wall opening.

The appropriate site for drainage is selected usually in the mid axillary line. The skin and deeper structures of the chest wall are infiltrated with a local anæsthetic. The rib is cut down upon through a small incision parallel to it and a small section removed. A sponge is held in the left hand, while with the right hand a blunt forceps is forced into the empyemic cavity. The jaws are now separated enough to make an opening of about  $\frac{3}{4}$  inch. Instantly covering the wound with the gauze sponge held in the left hand to prevent immediate escape of the pus the free hand introduces the valve under the sponge, into the chest wall. When an empyema is entered in this manner much soiling of dressings and those about is avoided.

The operation of the valve may now be observed. The patient coughs slightly and as this

increases intrathoracic pressure quantities of pus and air rush out through the valve, then, as the thoracic wall relaxes there is produced an intrathoracic vacuum. The rubber tissue cover of the tube will then be observed covering the tube opening tightly through suction. An indentation over the valve hole can be seen. Although the amount of cough will be much less under these circumstances coughing will be frequent enough to maintain a constant intrathoracic vacuum.

Dressings may be applied over the device without fear of altering the mechanism the same may be said of their removal. It will be found that the flap will remain in place constantly, unless it is deliberately lifted from over the tube opening.

Instead of the patient having to depend upon adhesions to draw his collapsed lung back into its normal place against the chest wall, the constant vacuum described does it for him.

When an empyema develops on the opposite side or is already present, the other side may be operated upon in a similar manner within a few days. Collapse of both lungs and asphyxiation, which would necessarily happen if both sides are left open in the usual way, need not be feared.

In the author's experience this device has never failed to keep up a constant vacuum as long as there is a cavity present. When it is found after a few weeks that the rubber cover is no longer being sucked against the tube, the cover may be lifted and the lung inspected through the tube opening. It is considered advisable to allow the tube to remain in place for at least 4 days after this point in the postoperative care has been reached. If such allowance is not made, and the tube is removed the patient may sneeze or cough suddenly which is likely to tear the lung away from the chest wall again and collapse it. If this very preventable condition should occur the replacement of the valve at once, will bring the lung back against the chest wall again within a few hours. Time may then be given for its firm attachment, before removal of the valve is again considered.

The postoperative shock and disturbance which at times is severe in these cases is thought to be due more to the augmented cough and distress incident to the sudden final collapse of the affected lung than to the operation itself. The use of the device and technique here described has seemed in the author's experience to produce a more rapid convalescence. It is thought much toxin laden lymph is extracted from the affected lung and pleura by the vacuum created.

Most of these cases are in a desperate weakened condition before they reach operation. They

<sup>1</sup>It is important that the size of the Wilson tube selected in each case shall be a longer and preferably some also try this. The total thickness of the chest wall at the site of operation. It has been found that the smallest size Wilson tube works very well on all children and the next size measuring  $\frac{1}{2}$  inch is correct for practically all adult cases. The  $\frac{1}{2}$  inch Wilson tube should be used only on the very thick walled obese patients. Observation of these simple directions, together with care in not making the pleural opening wider than  $\frac{1}{2}$  inch should insure a snug fit of the tube.



Fig 1 Tucker McLane forceps

colpeurynter, especially when the membranes have ruptured early, is indicated. Rarely when progress has apparently ceased in spite of continued labor what remains of a soft readily dilatable cervix can be easily stretched by gentle manipulation. More rarely the rim of an incompletely dilated, rigid cervix must be incised and repaired after delivery. To attempt delivery through an imperfectly dilated os is to invite complications far worse than that which already exists.

Operative treatment is seldom indicated before the advent of the second stage, and even then is frequently unnecessary. The occiput rotating spontaneously in over 70 per cent of the cases. A simple prophylactic forceps operation with or without episiotomy, may then be considered optional.

Postural treatment (having the patient lie on the side toward which the fetal back is directed) for the correction of the faulty attitude and to bring about internal rotation, while a perfectly commendable procedure, is obviously difficult in a patient who is under the influence of anesthesia, and who is therefore unable to co operate.

In about 5 per cent of the cases the head after complete dilatation, is found floating or is arrested high in the pelvis. For this small group version followed by breech extraction, particularly in the multipara is favored by most obstetricians, especially when intact membranes facilitate turning of the child.

In the 25 per cent remaining the head is found arrested at various levels within the pelvis. The occiput still occupying its relation to the posterior quadrant. For the treatment of this group, a number of methods have been suggested. All of them in competent hands are productive of good results. The principal aim of each of them is directed toward the same end, namely, rotation of an occiput posterior to an occiput anterior while the means by which rotation is accomplished is either the hand of the accoucheur or the obstetrical forceps.

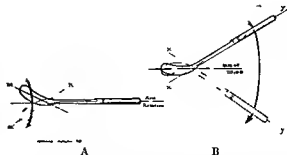


Fig 2 A The wrong way. Twisting the instruments around the axis of the handles causes the tips of the blades to describe an arc within the pelvis thus tearing the bladder and vagina loose from their attachments. B The correct way. Rotation of the handles through an arc causes the blades to revolve about their own axes. Thus the integrity of the maternal soft parts is preserved.

While it may be true that the best method is that one to which the operator has best trained himself, it is no less true that manual correction usually calls for the insertion of the whole hand into the vagina with displacement of the head upward and out of the pelvis to secure the degree of internal rotation necessary. This procedure however increases the danger of infection and invites the possibility of prolapse of the cord. Even after rotation has been accomplished in this manner backward rotation of the occiput, after the hand is withdrawn from the head and before the blades of the forceps can be applied, is an exasperating and frequent occurrence. DeLee recommends here the use of an Allis clamp or of a double volsellum forceps, by which the scalp, after rotation is firmly grasped and steadied by an assistant until the forceps can be applied.

The Pomeroy maneuver, recently described by Aranow is manual rotation whereby the body of the baby is rotated on its own axis 180 degrees, thus bringing the sagittal suture back into the same oblique diameter of the pelvis. In this manner the right occipitoposterior position (occiput dextra posterior, 135 degrees) is converted into left occipitoanterior (occipito laevus 45 degrees) or left occipitoposterior (occiput laevus posterior 135 degrees) into right occipitoanterior (occiput dextra 45 degrees).

The method of Tarnier and that of Hodge, both aim at correction of the malposition by intravaginal manipulation and digital pressure, without displacement of the head. Both methods sometimes produce the desired result.

Until comparatively recent years rotation was not included among the 'properties' or 'functions' of the forceps. Smellie in 175-, was perhaps the first to perform instrumental rotation.

## THE MANAGEMENT OF THE OCCIPITOPOSTERIOR POSITION

WITH SPECIAL REFERENCE TO THE MODIFIED SCANZONI MANEUVER

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**D**URING recent years much has been said and written concerning the proper management of those cases which come under the caption of this paper. In spite of excellent contributions to the literature on this important subject, to the physician who practices obstetrics today the occipitoposterior position remains still a bugbear.

The careful analysis of former labors in cases presenting the past history of stillborn children or of infants who succumbed shortly after instrumental delivery, often reveals the earmarks of faulty management of this common complication. Errors in the diagnosis and treatment of this position are observed so frequently that one wonders if the fault does not lie universally with the instruction of obstetrics, rather than with the instructor. DeLee justly ascribes to the improper conduct of these cases the appalling annual total in the United States alone of several thousand infant deaths and hundreds of maimed or invalided mothers.

Any condition which causes so much avoidable mortality and morbidity calls for an inventory of the various methods whereby these unhappy results can at least be reduced in number.

It has been estimated that 95 per cent of all cases are vertex presentations at the beginning of labor. In approximately one third of this number the occiput is directed posteriorly—right occipitoposterior (occiput dextra posterior, 135 degrees) or left occipitoposterior (occiput laevus posterior, 135 degrees). For the same reasons that explain the greater frequency of the left anterior position, left occiput anterior (occiput laevus 35 degrees) the occiput in most posterior positions is in the same oblique diameter, right occiput posterior (occiput dextra posterior 135 degrees).

The mechanism of labor in the posterior position presents one main difference from that in the anterior position—rotation in the former takes place through an arc of 135 degrees while in the anterior position the occiput describes an arc of 45 degrees.

Engagement of the head in occipitoposterior position occurs more slowly partly because of the promontory, and partly because an almost constant deflection or 'military' attitude of the presenting part brings a less favorable cephalic

diameter (the occipitofrontal instead of the suboccipitobregmatic) into the pelvic inlet. Because of the existence of these factors all of them unfavorable in tendency—internal rotation of the head in the posterior position, if it occurs at all, consumes more time.

Often the membranes rupture early, delaying the progress of labor and as the hours drag by increased risk to mother and babe is inevitable. Exhaustion, inertia and hemorrhage threaten the mother, while the prospect of a stillborn child becomes real in the neglected case. Lacerations here are more extensive than usual especially if the head rotates posteriorly to the hollow of the sacrum. It is not surprising therefore, that 'more children are lost from this complication than are lost from the effects of contracted pelvis' (DeLee).

To minimize these dangers by whatever means assure him of the best results, becomes the duty of every obstetrical attendant.

The proper management of a given case begins with the diagnosis of position. Failure to do this early or failure to do it at all is responsible for no small share of the misfortunes attributed to this position. The consequences of error are here so hazardous that every vertex labor which does not proceed smoothly should be carefully scrutinized for the possibility of a mistake in this direction.

Once the existence of posterior position has been established the prudent attendant fortifies his patience, adopts an attitude of watchful expectancy, and awaits some indication for interference.

The greatest danger during the period of dilatation in the average case is exhaustion of the mother. To offset this morphine and scopolamine, rectal anesthesia or analgesia and a labor room free from baneful external stimuli such as bright light, noise or conversation are the main stays during the first stage. All internal examinations are made through the rectum. Rupture of the membranes is to be prevented if possible until the cervix is completely dilated. Expulsive efforts on the part of the patient, while not to be encouraged during the first stage of any labor are here particularly to be condemned.

Usually the cervical canal if given time enough will spontaneously become completely effaced and the os fully dilated. At times, however, the

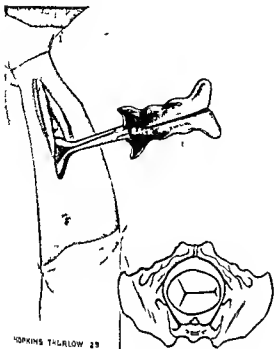


Fig 5 Rotation to right occiput transverse No traction

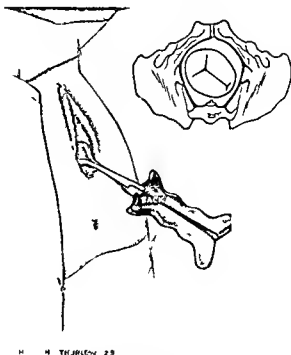


Fig 6 Rotation to right occiput anterior No traction The handles describe a wide arc

occipito-anterior (occiput *laevus* 45 degrees) the pelvic curve of the forceps in the initial application thus being directed toward the baby's forehead. An accurate cephalic application is essential to avoid slipping of the blades during rotation (Fig 3).

The forceps are now locked. To increase flexion and to free the head from the grasp of the soft parts the handles, gently compressed are carried to the patient's thigh toward which the baby's face is directed. In this movement the handles traverse a line parallel with that of the sagittal suture (Fig 4).

From this point rotation is accomplished with a gentle sweeping motion the handles describing a large arc, thus keeping the blades in approximately the same axis (Fig 2 B). The fingers of the free hand meanwhile, are touching the occiput to apprise the operator of the degree of anterior rotation. Rotation is continued until the occiput, passing through the transverse and the anterior positions, finally occupies the directly anterior or zero position, and the handles of the forceps, inverted become directed toward the floor (Figs 5 and 6). No traction has been employed up to this point. The head has rotated in the same plane it occupied at the beginning of the maneuver, and

only the abnormality of position has been corrected. Excessive force to accomplish rotation is contra indicated.

To overcome backward rotation of the occiput slight traction toward the floor is now exerted upon the inverted handles. This fixes the head in its new position before the second application is made.

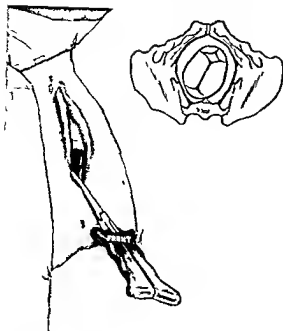
In the re application of the forceps, the posterior blade is inserted first. This aids in steadying the head and preventing its displacement during the application of the anterior blade.

The pelvic curve of the instruments now is directed toward the occiput.

The remainder of the delivery is completed exactly as that of any other occipito anterior position.

The use of the forceps to accomplish delivery in cases of posterior position has become increasingly popular. Special types of blades as the Kjelland forceps have been devised. Seides, emulating Bill introduced his 'two forceps maneuver,' while later DeLee described his 'key in lock' operation.

It may not be amiss here to add that not force, but art is the prerequisite to every obstetrical procedure. The untutored hand reflects its lack of skill in dead or mutilated children,



HOPKINS THURLOW-29

Fig. 3 The first application is the same as for the opposite anterior position



HOPKINS THURLOW 29

Fig. 4 Elevation of the handles to increase flexion and to free the head

In 1865 Scanzoni devised a method of delivery, whereby rotation and traction together were the principal features. It was after him that the original Scanzoni maneuver for the treatment of occipitoposterior positions derived its name. But rotation in these instances was doubtless imparted to the head by twisting of the handles of the forceps (Fig. 2A) for it was not until later (1881) that Tarnier brought forth the idea of sweeping the handles through a large circle to effect rotation of the head within the pelvis.

Needless to say, traction with rotation in the form of a spiral twist was not long popular, and as a consequence of many serious injuries to the pelvic floor attributed to this operation, the Scanzoni procedure fell into disrepute.

It remained for Bill, of Cleveland, by the "modified Scanzoni maneuver to prove unmistakably that the forceps can properly and safely be used as a rotator and that in this respect it is often superior to the hand in that the blades do not displace the head as does the hand. Indeed, to the accoucheur the forceps is but an extension of the hand and should be used as such in the performance of his art—much as the surgeon uses his knife or as one uses a pen with which to write. The instrument is but the agent through which the hand operates.

The technique of this operation is neither difficult nor dangerous. Properly executed it provides not only a beautiful obstetrical maneuver, but also a means by which may be avoided many of the unhappy results accredited to this position of the head.

It is necessary first that the attendant be familiar with the use of instruments and that all of the conditions governing the use of forceps be present. After the bladder is emptied the maternal soft parts are carefully prepared by the liberal use of a neutral liquid soap which not only assists in ironing out the pelvic passageway, but acts as an ideal lubricant for the passenger as well. The exact position of the head is then carefully determined, the posterior ear being located if necessary.

The choice of forceps depends upon the operator. Those commonly preferred are the Tucker-McLane variety (Fig. 1) solid blades with a long shank. The reason for this preference lies in the ease of their introduction, rotation and with drawal which renders their selection ideal for this operation.

The first application is made exactly as for the opposite anterior position. For right occipitoposterior (occiput dextra posterior 135 degrees) the first application then would be as for left

## AN ORIGINAL METHOD OF CLOSURE OF A PARTIALLY APERITONEAL OR SHORT INTESTINAL END

GOLDER LEWIS McWHORTER Ph D M D, F A C S CHICAGO  
 Assistant Clinical Professor of Surgery Rush Medical College of the University of Chicago

THERE is at present no thoroughly satisfactory method for closure of a short or partially aperitoneal intestinal end or one which has been cut short. As a result, leakage frequently occurs.

It is necessary to have a wide approximation of aperitoneal intestinal surfaces, which do not ad here so firmly as when covered with peritoneum, and to use preferably non absorbable suture material.

After resection of the duodenum and the ascending or the descending colon, there is usually a portion of the circumference not covered with peritoneum and there is frequently a short stump.

In an effort to avoid leakage from the lumen of the colon it is customary to use a side to side instead of an end to end anastomosis when the segment is not completely covered with peritoneum. Frequently a proximal colostomy is also done to safeguard closure of the ends of the colon.

After invagination, a partially aperitoneal or short intestinal end is usually covered with omentum and sutured to the peritoneal surface of an adjacent viscus or to the abdominal wall near the incision. A small drain may be inserted so that a possible leakage will find its way externally.

An original method of firmly invaginating short or partially aperitoneal intestinal ends has been used satisfactorily. This method is adapted particularly to closure of very short duodenal stumps, which, necessarily, may be cut close to the lesser pancreatic duct and to important blood vessels.

## TECHNIQUE OF INVAGINATION

The intestine is cut off, preferably beyond a clamp applied so that the middle of the aperitoneal portion or short side forms one corner or angle (Fig 1, A). If possible the stump is invaginated without opening the lumen. This may be done by inserting a Cushing running suture from side to side over a crushing clamp, traction is made on the two ends of the suture after the clamp is removed.

When the intestinal end is cut very short, it is frequently impossible to use a clamp. The running invagination suture should then be started from the middle of the aperitoneal surface—the critical corner.

A fixation suture further to invaginate this corner is passed from it (Fig 1, A) to the intestinal wall some distance downward and as nearly opposite to it as to produce the desired invagination. If the intestinal stump is fairly long the

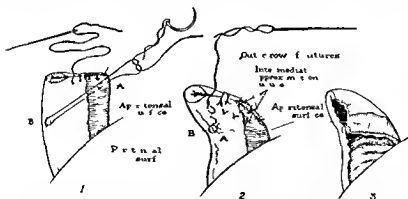
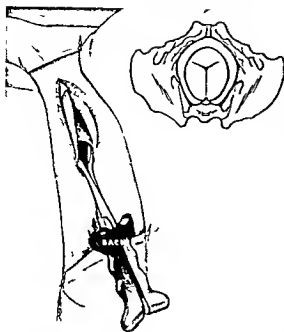


Fig 1 The critical corner A should be located in the middle of the aperitoneal portion of the intestinal end on the short side or next to a vital structure. A suture passed from this corner 1 to the opposite wall B assists in the invagination.

Fig 2 If possible closure of the intestinal lumen is done without opening it by suturing over a clamp. Several rows of sutures firmly fix the invagination of the end.

Fig 3 The desired maximum invagination of the intestinal end is illustrated. There is no disturbance of the blood supply.





H. H. 15 THORLOW 29

Fig 7 Rotation to the zero completed. Traction at this point to fix the head before the re application

and in extensive damage to the birth canal. The excellent survey of Douglas Miller reveals 2 cases of fracture of the parietal bone and 7 dead children after forceps rotation and delivery in 35 cases! To employ such force as is required to fracture an infant's skull is reprehensible to say the least. Since failure of the head in the posterior position to descend spontaneously is usually due to the

faulty position, forcible traction upon such a head, to bring it to a lower pelvic plane before rotation, is also reprehensible.

#### CONCLUSIONS

- 1 The diagnosis of position is essential to the proper management of any labor.
- 2 Occiput posterior positions if neglected cause increased fetal mortality and maternal morbidity.
- 3 Usually during the first stage of labor in these cases, interference is not indicated except for conservative treatment for the support of the patient.
- 4 In the second stage rotation of the occiput manually or by means of forceps is often necessary to complete the delivery.
- 5 The modified Scanzoni maneuver, if more thoroughly understood, offers here certain advantages over other methods of delivery.

#### REFERENCES

- ARADON H. The Pomeroy maneuver. *New York State J Med* 1926 xxvi 961.
- BILL A H. The modified Scanzoni maneuver. *Am J Obst & Gynec* 1923 ix 342.
- DELEE J B. Principles and Practice of Obstetrics 4th ed. also *Am J Obst* 1918 lxxviii 791.
- EISENBERG C. The Kjelland forceps. *Med Klin* xx 1694.
- Idem. The treatment of occiput posterior position after engagement of the head. *Surg Gynec & Obst* 1928 xlv 696.
- JARCHO J. The rôle of posture in obstetrics. *Surg Gynec & Obst* 1929 xliii 237.
- MILLER D. A survey of 750 cases of occiput posterior positions. *Tr Edinburgh Obst Soc session lxxvi* 1927 p 77.
- SEIDES S A. Two forceps maneuver. *Surg Gynec & Obst* 1923 lxxvi 421.
- WILLIAM J W. Textbook of Obstetrics 3d ed.

# EDITORIALS

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## SURGERY, GYNECOLOGY AND OBSTETRICS

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JUNE 1930

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### THE AMERICAN HOSPITAL

THE American hospital, like most American institutions, was modeled on the English plan, but in some very important respects the relations of the hospital to the public have been changed for the better. Whereas in England the fine public hospitals, well equipped and staffed with the best men that England affords, retain their primitive characteristics of caring only for the charity patient, in America generally speaking, there has grown gradually the plan that was adopted in 1889 when St. Mary's Hospital in Rochester was opened, of caring for all classes of people in the same hospital. It is becoming generally recognized that sickness is no respecter of persons and that the sick man regardless of race, creed, social or financial condition, is entitled to proper care, and that those at the upper end and middle of the financial scale should receive the same care as those at the lower end.

In one important respect however, the American hospital maintains something of the fundamental characteristics of those earliest institutions from which sprang the modern

hospital. Public hospitals in England were built to take care of those persons who had no other place to go, and they, therefore, were in every respect charitable organizations. They were not supported by public taxation, but by appealing to the generous minded for aid, and comparatively few of these splendid English institutions have endowments which are anything like adequate for their purposes.

The remarkable change in medicine which was brought forward by the discoveries of Pasteur and their application by Lister, changed the entire conception of hospitalization. From being a possible source of contagion and infection to all within its walls, the hospital, with the disappearance of such malign influences, became the safest retreat for the sick, and as we look at the hospital today, for those who are seriously ill and especially those requiring surgical operation, it has become the haven of refuge.

Unfortunately, in this more modern understanding of the hospital, the public has retained the attitude that the hospital must be supported, at least as far as the charity cases are concerned, by an appeal to charity, or to put it more frankly, the hospital is left to shift for itself as nobody's business.

The services of the medical profession for the poor are the one thing that all hospitals give away freely. I am proud to belong to a profession so truly humanitarian. The expenses of the hospital other than for medical services must be paid, however, and while it occasionally is the good fortune of an institution to have endowments or support from generous minded citizens, the large majority of hospitals have no such resources and either

suture may be introduced into the opposite wall, proximal to the end (Fig 1, *B*) by about the width of the lumen

Intermediate sutures of chromic catgut and a final row of intestinal approximation sutures, preferably of a fine, non absorbable material are inserted (Fig 2)

If the invagination of the critical corner (Fig 3) is carried beyond the line dividing the aperitoneal from the peritoneal surfaces, it will anchor them more firmly

If a very short intestinal end occurs and invagination is thus limited, an inversion and fixa-

tion suture may be passed from the critical corner to some point in the side of the intestinal wall along a line from *A* to *B* in Figure 1. This step will produce a maximum of invagination

The technique described may be used in the closure of any short intestinal end and will secure the maximum invagination of the corner which is nearest to the blood supply or to other important structures. Occasionally it may be desirable to secure both of the corners and anchor them in this manner

The method does not interfere with the blood supply

on the part of the public that it is their duty to care for the sick unable to pay, a duty which they recognize in the care of the insane and criminal

W J MAYO

### SOME FACTORS INFLUENCING PERMANENT HEALING OF MALIGNANT TUMORS

**R**ADIUM is not as much used in the treatment of malignant tumors as it should be—of that there can be little doubt. Reports from many expert workers in the field of radiation indicate an encouraging number of permanent healings in cases otherwise hopeless, yet many surgeons of wide experience will tell you that they have never seen a cure resulting from radium treatment. Several reasons have contributed to the skepticism of so large a number of the profession. Perhaps the most important is the almost prohibitive cost of radium, making it difficult to secure an amount adequate for effective use, but there are others, such as its application as a last resort in hopelessly advanced cases, the unwise selection of cases for its use, and above all lack of experience in its use in the earlier years following its introduction.

Forssell<sup>1</sup> has given a most complete and careful monograph on this subject. His report is based on a study of 1,448 patients treated at Radiumhemmet, a hospital for the treatment of cancer established in 1910 by the Stockholm Cancer Society and now receiving support from the Swedish Government. The results of the treatment have been followed at intervals for as long as 15 years in some cases. This is made possible by the fact that the Swedish Parliament voted to defray the traveling expenses of all patients too poor to bear the expense themselves.

During the first years of the institution only such tumors as were inoperable were treated

Later with improved technique and a larger supply of radium, borderline cases were treated, and of late years certain operable cases have been also treated in which the results seem to indicate that radiotherapy gives better results than surgery alone or surgery combined with radiotherapy. In addition to its curative value, experience also indicates that in many hopeless cases radium offers a means of materially delaying the progress of the disease and alleviating symptoms, in certain instances giving a degree of relief which makes it possible for the patient to return to his usual vocation for a considerable length of time.

The insufficient amount of radium generally available for treatment is repeatedly emphasized in Forssell's paper. While there is no such thing as a fixed "cancer dose," a certain minimum amount is necessary. This makes it possible to apply the radium for the shortest time, by preference in a single sitting. Repeated treatments are advised only in cases in which the situation of the growth suggests the danger of too great reaction or damage to surrounding tissues, making it impossible to apply the dose at one treatment. In certain groups of cases, for example cancer of the uterus, radium is used almost exclusively, with exact local distribution at two, or at the most three treatments, over a short time usually from 3 to 4 weeks. On the other hand sarcomata are frequently treated by X ray alone or by a combination of radium and X ray therapy.

A factor of equal, or perhaps greater importance than inadequate amount of radium has proved to be the inexperience of the operator. During the early years of its use, from 1910 to 1913, the treatment was to a considerable extent experimental in an effort to elaborate a satisfactory technique. Early in 1914, when the technique had been fairly well established on a basis of a considerable experience the

must fail in their full duty to the patient or make an increased charge to the sick within the hospital who do pay, sufficient to cover the cost of maintaining care for the large number of patients who are unable to pay.

The injustice of this disregard for the sick man, already crippled in his resources by his own misfortunes in being obliged to bear taxes imposed on him for the care of others who are unable to pay, is manifest, and the financial burden lies not alone in the cost of room and board and in the cost of nursing, but in addition in a series of charges for the use of the operating room laboratories, X-ray medicines, dressings, and other details of hospital care, which are as unexpected to the patient as they are embarrassing. Altogether a financial burden so great is imposed that the common man hesitates to enter a hospital even when it is obviously for his own best interest. It is true that in the large cities, charity hospitals are maintained by the public but the self-respecting American citizen of small means has pride, he has no desire for either himself or his family to accept charity and yet his only recourse is either to swallow his pride or strain his financial resources to the utmost.

The community hospital must and does accept whatever sickness is brought to its doors. The automobile wreck, for example, throwing the burden of a number of persons seriously injured on the hospital, has become a financial menace to these hospitals. Many small community hospitals throughout the country have been financially ruined by automobile accidents. The hospitals are not responsible for the wrecks, but they cannot refuse to care for the injured.

The costs of such care should not be thrown on the hospitals but on the public. In large cities, most general hospitals no longer maintain an ambulance service but leave that

service in the hands of the public hospital in order to avoid financial embarrassment. The manifest duty of the governing bodies, municipal, county, or township, is to place this burden on the public where it belongs. Why should it make any difference where the patient is situated if he is a proper object of public support and is cared for well and economically? The medical care costs nothing in either case. In the large majority of instances governing bodies pay nothing, in others some conception of duty will be found but as a rule the amount they pay is less than the actual cost of care for the patients.

The high cost of hospitalization is a matter of concern to all good citizens. The sick man is a liability to his community, but he may be converted into an asset if he is made well as quickly as possible. Let us not forget that the hospital is a community necessity and not a profitable business.

The trained nurse has been accused, in the main unjustly, of contributing to the high cost of sickness. We must consider that the nurse has put in three years of twelve months each in her training and that her responsibilities are great and her hours are long. Few nurses after many years of conscientious labor have sufficient savings to be independent in their old age. It is equally true that the superior position which the nurse should occupy by reason of her training is not attained, and that much of the work that she does could and should be done by a hospital maid under her direction with a great reduction of the cost to the patient.

In the new hospitals that are to be built I look forward to seeing far-reaching changes in planning construction and business management which will give sick people in moderate circumstances privacy and good care within a price that they can afford. And above all I look forward to a realization



percentage of absolute healing rose rapidly for example, in cancer of the uterus the percentage improved from 26.9 per cent in 1914 to 32.5 per cent in 1915. The treatment was then placed in the hands of another physician, lacking experience, and the figures for permanent healing sank to 8.5 per cent and later to 14.3 per cent respectively for the 2 years 1916 and 1917. When the new physician had gained sufficient personal experience the figures rose to the old level for the years 1918 to 1921.

This seems to show most strikingly the importance of establishing clinics in larger centers where patients apparently suited to this form of treatment can be received and carefully studied as to the best form of treatment, whether by surgery alone, by surgery and radiotherapy combined, or by radium alone. Forssell's careful follow up over such a long period of time gives convincing evidence

of the permanence of cure in a large number of cases. It is manifestly impossible for the vast majority of individual workers and for most small communities to support a radium clinic where a really sufficient amount of this expensive element can be obtained and held available for use. There are a few such clinics in our country, but unquestionably there is great need for the establishment of a much larger number of such centers of treatment for otherwise hopeless cases. The results also conclusively show the value of co-operative effort of large groups of medical men in referring patients and in follow up of results, thorough study of technique and its adaptation to the individual case, ample supplies of radium and apparatus. These with the experience of the operator and his adaptability to the work are certain to have a highly important influence upon future treatment of malignant tumors.

MARTIN B. TINKER, M.D.

# MASTER SURGEONS OF AMERICA

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MARCUS WHITMAN

THE first surgical operation performed by an American physician west of the Rocky Mountains was performed by a young doctor from New York state, Marcus Whitman, M D , in the latter part of August, 1835. The place was the annual rendezvous of fur traders and Indians on Green River, Wyoming, and the patient was the famous scout, Captain Jim Bridger. The surgeon removed an iron arrow head, three inches long, from the patient's back where it had been embedded for three years. The arrow head was crooked at the point and a cartilaginous substance had grown around it, rendering the operation difficult for that day and place, but it was completely successful and the reputation of the physician was established. Similar operations were followed by an urgent demand for his medical and surgical services, while his kindness and firm, upright character won for him for the rest of his life the title "The Good Doctor." Dr Whitman was a man of remarkable physique, about five feet ten inches high, deep chested, and with a large head set close upon broad shoulders. His endurance and physical strength were remarkable. He had the body and the mind of the explorer, the adventurer, and the scientist.

The young surgeon, thirty three years of age, had crossed the continent with a companion, Rev Samuel Parker of Middlefield, Massachusetts, to explore the Pacific Northwest as representatives of the American Board of Commissioners for Foreign Missions, and to report to the Board concerning the feasibility of establishing a mission among the Indians. Romantic rumor had reached the East a year or two earlier that the Indians of Oregon Territory were asking for the gospel and the result was the sending of this investigating committee, consisting of a doctor and a minister, to determine the question.

The number of Indians at the rendezvous in 1835 was so great and the information derived from them and from the trappers was so impressive that Dr Whitman returned East for reinforcements to establish at once a mission among the Indians. The following summer he returned to Oregon with his bride, Narcissa Prentiss Whitman, Rev Henry Harmon Spalding and his bride, and a young man, William H Gray, who came as general factotum, and was later to become the first historian of Oregon.

Dr Whitman and his wife were both of New England stock, their ancestors having settled in Massachusetts from England before 1635. They were well





MARCUS WHITMAN  
180- 1847

mission of Mr and Mrs Spalding at Lapwai, 120 miles to the east, to Tshimakain, 150 miles to the north, where, in 1838, a new mission of the American Board had been begun by Rev Cushing Eells, Rev Elkanah Walker, and their wives, and even down to Vancouver, 300 miles westward, where the great post of the Hudson's Bay Fur Company was located. It was a record of service rarely equaled in the missionary annals of the world.

But Dr Whitman was fated to play a more important part than that of pioneer physician and surgeon in the Pacific Northwest. In those days the ownership of the Northwest was in doubt. The land was held under a treaty of joint occupancy between England and the United States, with the understanding that eventually the country which had the greater number of settlers in the field would become its owner. But the people of the United States were ignorant of its value, while the British Hudson's Bay Company was actively at work, deriving a rich annual revenue from trade with the Indians. Dr Whitman learned the fertility of the soil, the vastness of the river system, the extent of its forests, and its mineral resources. He became profoundly convinced of the value of the country to the United States.

In September, 1842, a little party of travelers from the East brought word that a new treaty was about to be negotiated between England and the United States, which, it was believed, would settle the Northwest boundary line. In the absence of reliable information concerning the value of the country it was likely that the United States would amiably allow Great Britain what she desired in the Northwest, in return for concessions elsewhere. Dr Whitman resolved to inform his government concerning the great value of the land of his adoption. To the remonstrances of his fellow missionaries he said, "Gentlemen, though I am a missionary I am not expatriated. To Washington I will go."

On October 3, 1842, he started to cross the continent with one white companion Lovejoy, who had just brought from the East the news of the impending treaty. Dr Whitman had other business than interviewing the government at Washington, for his fellow missionaries had entrusted him with important correspondence addressed to the American Board at Boston, but his primary object was political, and he went first to Washington by the most expeditious route.

His winter ride from Walla Walla to Washington was full of romantic and terrible adventures. It has been called "the greatest ride in history." Blocked by Indians on the warpath, and snows in the northern mountains, he turned south through Utah and made his way to Bent's Fort on the Arkansas River. Thence he hastened to Washington, his face and hands and feet frozen by exposure. Lovejoy remained in the Mississippi Valley to arouse interest in Oregon and urge people to join the wagon train which, it was hoped, would cross the continent that summer.

educated for their day, and came from comfortable homes of godly and hard working parents who lived thriftily on the frontier of western New York. Dr Whitman had been educated at Plainfield, Massachusetts, where he studied Latin under Rev. Moses Hallock. Then his family moved to Rushville, New York, and he studied medicine under Dr. Ira Bryant of that place. He had received his diploma at Fairfield in 1824, and had practiced medicine for four years in Canada and afterward in western New York. He had also gained a valuable business experience by a partnership with his brother in the management of a saw mill near Potter Center. His active mind, physical vigor, and adventurous disposition had made him eager for a larger field, and he had offered himself to the American Board "as physician, teacher, or agriculturist."

Mrs. Whitman was twenty-eight years of age, tall and noble looking, with golden hair, a gracious manner, and a lovely voice. An experienced teacher, she gave herself, heart and soul, to her husband's work. Her coming and that of Mrs. Spalding marked the true beginning of American civilization on the Pacific Coast. Until woman comes the home is lacking.

Dr. and Mrs. Whitman settled at Waulatpu, six miles west of the present town of Walla Walla, Washington, and began their life work for the Indians. The doctor installed his bride in a log cabin made from trees which he cut in the Blue Mountains, twenty miles away. The floor was hard trodden clay, and across the openings in the rough walls skins and blankets were hung to keep out the cold night air and the prowling savage. Here Mrs. Whitman established the first American home on the Pacific Coast, and here, on March 14, 1837, the first white child of American parents was born, Alice Clarissa Whitman.

When an American traveler, T. J. Farnum, visited the Whitman mission in 1839, he found that the young doctor and his wife had accomplished great things in a short time. In his diary for September 23 he wrote: "The old mission house stands on the northwest bank of the river, about four rods from the water side at the southeast corner of an enclosure containing about two hundred and fifty acres, two hundred of which are under good cultivation. The products are wheat, Indian corn, beans, pumpkins, Irish potatoes, etc., in the fields, and beets, carrots, onions, turnips, rutabagas, water, musk and nutmeg melons, squashes, asparagus, tomatoes, cucumbers, peas, etc., in the garden—all of good quality and abundant crops." A large mission house, 100 feet by 40 feet for the use of travelers and future immigrants, was in process of construction. A grist mill, the first in the Inland Empire, was in operation.

During these years of active work as pioneer and farmer, Dr. Whitman had learned the Indian language, had helped his wife with her teaching of the Indian boys and girls who crowded to the first school east of the Cascade Mountains, had ministered to the physical and spiritual needs of the Indians, and had acted as physician and surgeon for distant regions going when needed to the

Measles broke out among the Indians near the mission in the fall of 1847 Dr Whitman treated the patients among the Indians and among the visiting white immigrants with the same remedies, but many of the Indian patients died Taking his remedies, they followed also the Indian custom of a sweat bath In a low lodge of closely woven boughs by the bank of the river, water was poured on heated stones to make steam in which the sick were laid, emerging at last, dripping with sweat, they leaped into the ice cold stream When many of them died under this treatment it was whispered that Dr Whitman had poisoned them An Indian custom dictated revenge

On November 29, the discontent and hate which had gathered like a storm suddenly broke Dr and Mrs Whitman were killed and scalped All the boys and men in the mission were also killed, while the women and children, some forty in number, were held by the Indians for their own purposes and for ransom In the lust for blood and destruction the mission buildings were burned down the orchard was hacked to pieces, and scarcely a vestige left of the mission station in which the good doctor and his wife had spent their lives for those who slew them

The closing scene in the life of Dr Whitman saw him in the rôle of physician ministering to the sick Three Indians, wrapped in blankets, had come to the door of the mission and asked for medicine As he bent over his medicine chest to select the proper remedy for the sick Indian, one of the others slipped behind him and, raising his tomahawk, struck a glancing blow on the back of his head The doctor leaped for the throat of the other Indian but as he struggled the deadly tomahawk rose and fell striking the doctor on the top of the head penetrating the skull a fatal wound He died as the physician would like to die in the act of service Of him too, it might be said that "he came, not to be ministered unto, but to minister, and to give his life a ransom for many"

The one hundredth anniversary of the founding of the Whitman mission and the beginning of American civilization on the Pacific Coast will be celebrated in 1936 by the people of Walla Walla and the state of Washington in co-operation with Whitman College his living memorial

STEPHEN B L. PENROSE

Dr Whitman reached Washington on the third of March, 1843, and Congress adjourned the next day. He could make no impression on Daniel Webster, then Secretary of State, but was more successful with President Tyler. He obtained from the latter virtual agreement that no settlement of the Northwest boundary line would be made until the chance had been given to demonstrate that Oregon could be reached by wagons, and hence was accessible for settlement by the United States. Seven years before Dr Whitman had taken across the mountains the first wagon to the Pacific Northwest.

Horace Greeley wrote in the New York *Tribune* about Dr Whitman as he hurried from Washington, through New York, to Boston. He transacted his business with the American Board and reported that he was received coolly for abandoning his post. Then he turned westward and, after a brief visit in western New York state to see his family and the family of Mrs Whitman, he overtook the wagon train which had already started from the Missouri River, and was speedily elected its guide. Two hundred wagoos, eight hundred or more American settlers, and two thousand horses and oxen composed the great wagon train of '43 which moved slowly westward across the prairies, through the Rocky Mountains, past the post of the protesting Hudson's Bay Company at Fort Hall, over the Blue Mountains to Waulatpu, and down to the Willamette Valley. That wagon train blazed a trail so broad and clear across the continent that at once settlers poured westward in an unending stream. Soon the Americans vastly outnumbered the English and when by treaty, June 17, 1846, the Northwest boundary line was settled, it was drawn at the 49th parallel, instead of the mouth of the Columbia, or perhaps even the 42nd parallel the northern boundary of California. A vast region of immense natural resources had been saved to the United States by the wagon train of '43 and by the doctor who rode at its head, who had been prophet enough to foresee the value of the country and hero enough to risk his life to save it. Has any member of the medical profession rendered a greater service to his country?

After the great wagon train had left the mission station at Waulatpu, where it had rested and supplied itself with provisions, it traveled down the Columbia and out of the life of Dr and Mrs Whitman. This faithful couple, true to their original intention, settled down as missionaries to the Indians striving to do what they could for them intellectually, physically and morally. They quietly took up again their missionary work, healing the sick, teaching the young, advising and inspiring the tribes.

But it was evident that the coming of so great a tide of white settlers would disturb and terrify the Indians. They felt that they would be driven from their homes and they blamed Dr Whitman for his part in hastening the tide. The signing of the treaty and occupation of the country by the United States meant practically the signing of the death warrant of Dr Whitman and his wife.

# AMATI LVSITANI. MEDICI PHYSICI PRAESTAN-

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## OLD MASTERPIECES IN SURGERY

ALFRED BROWN MD FACS OMAHA NEBRASKA

### THE CLINICAL CASES OF AMATUS LUSITANUS

THE country of the ancient Lusitanians which comprised the modern Portugal and a part of Western Spain had been battered about and subject to various countries up to the middle of the twelfth century. It had passed through the stages of being a colony of Greece and later of Rome then coming under the Moorish domination until finally under Alfonso I it became a kingdom in 1139. It then flourished as an independent kingdom until 1580 when it lost its autonomy and became subject to Spain. During its early period it borrowed its medicine and its medical ideas from the country to which it was subject, becoming in turn medically Greek then medically Roman and finally during the period of Arabian domination Arabian in its medical thought. When it became a self ruling kingdom under Alfonso I it turned a little attention to medicine and founded two medical universities the first in Lisbon in 1290 and the second at Coimbra in 1307. These flourished up to the period of the Renaissance but produced practically no great men. Inheriting as it did the Jewish tradition in science and art many of Portugal's men of prominence in these fields were Jews and were driven out rather rapidly as soon as they obtained any prominence. Consequently they are found in other countries rather than in their native land.

It is rather interesting to note that these men dropped their own names and took either a part of their own name or an entirely new name and added to it the name of the ancient country Lusitania. So we find that one of the most prominent Portuguese of the sixteenth century called himself Amatus Lusitanus—Amatus of Lusitania. His real name was Juan Rodrigues de Castel Branco. He was born in the province of Beira in 1511 and was descended from a Jewish family which in order to be safe had through the force of public opinion embraced Christianity and followed that faith at least openly. Amatus did not follow his medical studies in Portugal either at the University of Lisbon or Coimbra but went to Spain and took his medical education in Salamanca where he studied under Alderate and attended the University at the same time as the famous Spanish physician Andres Laguna. He appeared to be particularly interested in surgery as he took a surgical service in two hospitals and then finding apparently that there was not sufficient opportunity for advancement in

Portugal left the country and went first to Antwerp and later to Ferrara. In the latter place he had the opportunity to follow out his anatomical studies through dissection both of human and animal bodies and says that he personally dissected more than twelve.

In 1549 he left Ferrara and went to the province of Ancona which had been annexed by the papal states in 1532 and there started to practice. In a short time he attained a very large following and a great reputation in surgery. However tragedy as it so commonly did in the sixteenth century stalked on the footsteps of success for in 1554 he was suspected by the Inquisition of following his former faith of Judaism. When this occurred there was only one thing for him to do and that was to leave Ancona and go to some country where he would be safe. In the meanwhile all of the wealth which he had gained during his residence in Ancona was seized by the Inquisition and a poor man he went to Pesaro where he was protected for a time by the Duke of Urbino. In spite of the fact that he was asked to go to Poland by the King he decided to go to Thessalonica now known as Salonica where Jews were free to worship in their own way and he then openly returned to the faith of his fathers.

Among his principal works of clinical interest is a series of case histories so to speak which he published in sections of 100 cases each. The first of these appeared in Florence published in 1551 the second in Venice in 1552. He then published a series of 400 cases at Basle in 1556 the fifth hundred at Pesaro in 1556 the sixth at the same place in 1558 and the seventh at Thessalonica in 1561. A completed collection appeared in Venice in 1557 before the publication of the sixth and seventh centuries as individual parts.

The general arrangement of this book is quite interesting. It consists of 400 clinical histories which are cited very carefully giving the symptoms physical signs and results of what had been done in the various cases. To the important ones there is appended what is called a Scholia. In this Amatus goes over the general principles of the disease under consideration discusses the various points and cites the opinions of other authors concerning it. It is noteworthy that Amatus although interested in surgery as a young man and evidently practicing it at the time this book was written did not himself practice surgery as in several places he advises sending for a surgeon.

## REVIEWS OF NEW BOOKS

THE second edition of *Science and Practice of Surgery* by Romanis and Mitchiner<sup>1</sup> is now available. This is an English work depicting English methods and ideas. An apology should be offered for this statement since in reality there should be no English or German or American school of surgery. Close contact through rapid transportation and constant interchange of thought and ideas is rapidly producing a school of surgery which is international. It is only in a detail here an improvement there an advancement of a physiological or pathological concept here today and its clinical application in a distant land tomorrow that afford any geographic distinction. Truly individual lands have an opportunity in that various diseases may be confined to a considerable extent to climatic or geographic locations as bilharziosis to Egypt yet the greater part of all surgical afflictions are world widespread.

This the second edition is a distinct improvement over the first and much of the material has been altered and brought up to date. In the description of massive collapse of the lung it is stated that 'An X-ray shows the diaphragm to be depressed and Treatment consists in applying a blister to the neck to counter irritate the phrenic nerve and giving an expectorant mixture. I fear these statements would not be accepted by the junior quiz masters in American medical schools.

In the discussion on thyroid surgery the preparation of the toxic cases should be more fully described. Every surgeon recognizes that this part of the treatment is most important in fact often the most vital one. No reference is made to the postoperative administration of iodine. Many statements in the division on gall bladder surgery are open to serious question. These few comments are intended as a constructive criticism as in general all surgical topics are exceedingly well covered. Special note should be made of the chapter on diseases of the joints the authors deserve much credit for the clarity and completeness of their presentation.

This work of two volumes is a complete of necessity at times brief survey of general and special surgery and offers the student with stated exceptions an excellent and complete text for the study of surgery. An added convenience is a complete index to the whole work at the end of each volume.

JOHN A. WOLFER

THE second edition of *The Principles of Electrotherapy and Their Practical Application*<sup>2</sup> is one of the best available books on electrotherapy. An excellent history of electrotherapy is given in the

THE SCIENCE AND PRACTICE OF SURGERY By W. H. C. ROMANIS; M.A. M.B. M.Ch. (Cantab.) F.R.C.S. (Edin.) & F. H. C. MITCHNER; M.D. M.S. (Lond.) F.R.C.S. (Eng.) 2nd ed. 2 vols. New York: William Wood & Company 1929.

<sup>1</sup>THE PRINCIPLES OF ELECTROTHERAPY AND THEIR PRACTICAL APPLICATION By W. J. TITCHELL; M.A. D.M. B.Ch. (Oxon.) D.M.R.E. (Cantab.) 2nd ed. New York: Oxford University Press 1929.

first part and in the second part are described the therapeutic actions of the various electrical currents. The chapter on the constant or galvanic current gives in detail the various experiments to show the lack of value as well as the value of this current. Details of interest are given as direct proof against the practicability of deep ionic medication.

In the chapter on the action of interrupted currents of low frequency the author likewise tries to judge scientifically the value of these currents. For instance, he says that although many special forms of current at varying rates of interruption have been designed and recommended by electrotherapists for exciting contraction in the involuntary muscles of the intestines the fact nevertheless remains that the involuntary muscles of the stomach and bowels are incapable of excitation by any of the currents employed in electrotherapy, and he explains the reason for this. But then he says that it is possible to treat indirectly certain forms of chronic constipation by stimulating the abdominal muscles.

There are also chapters on the therapeutic action of the high frequency and static currents. In the third part the action of radiant energy is considered. Electrical accidents are discussed in Part IV and electrodiagnosis in Part V. The last part of the book covers the application of electricity in certain disease conditions and tries to evaluate the application of these forms of treatment to various pathological conditions.

J. S. COULTER

THE fifth edition of the monograph on *Artificial Sunlight and its Therapeutic Uses*<sup>3</sup> is beautifully printed and well illustrated. Unfortunately the author is inclined to overemphasize the use of artificial radiation to the disadvantage of long established methods as is shown in the statement 'It is doubtful if any therapeutic measure effects as much good as ultraviolet therapy in diseases of the liver.'

The book is of greatest value to the specialist in this form of therapy.

J. S. COULTER

THE second edition of Fisher's book on *Treatment by Manipulation*<sup>4</sup> has been thoroughly revised and rewritten. Certain chapters have been enlarged especially those on osteopathy, tennis elbow, chronic arthritis and lesions of the sacro iliac joint. The author points out the danger of manipulation in improperly selected cases or when performed by inexperienced operators. He is very forceful in his condemnation of the unqualified practice of the bone setter and the osteopath. He divided into four main groups those cases which can be cured or benefited.

ARTIFICIAL SUNLIGHT AND ITS THERAPEUTIC USES By FRANCIS H. W. & HUMPHREYS, M.D. (Brux.) F.R.C.P. (Edin.), M.R.C.S. (E & L) R.C.P. (Lond.) L.M. (R. Dubl.) D.M.R.A. & E. (Cantab.) New York: Oxford University Press 1929.

TREATMENT BY MANIPULATION A PRACTICAL HANDBOOK FOR THE PRACTITIONER AND STUDENT By A. G. TIMBELL; Fisher, M.C. F.R.C.S. (E & L) 2nd ed. rev. New York: The Macmillan Company 1929.





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Attendance at the Philadelphia session will be limited to a number that can be comfortably accommodated at the clinics, under which plan it will be necessary for those who wish to attend to register in advance paying the registration fee of \$5.00. Attendance at the clinics will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of visiting surgeons among the several clinics and insures against overcrowding the number of tickets issued for any clinic being limited to the capacity of the room in which that clinic will be given.

by manipulation. They are cases with adhesions functional or hysterical cases unreduced dislocations or subluxations, and a miscellaneous group. He outlines, under diagnosis, the various symptoms of adhesions as follows: limitation of movement, pain, weakness, tenderness, and recurrent effusion. He discusses manipulative procedures of hip, knee, ankle and foot, shoulder, elbow, wrist, hand and spine.

The author's qualifications are excellent. His material is well chosen and presented. The discussion on osteopathy and chiropractic should be read generally by the profession. This small book should be of value to every orthopedic, industrial, or traumatic surgeon.

PHILIP LEWIN M.D.

**CHANDLER** and **Burton Wood** have written a monograph on lipiodol in the diagnosis of thoracic disease,<sup>1</sup> which might well be used as an example

<sup>1</sup>LIPIODOL IN THE DIAGNOSIS OF THORACIC DISEASE. By F. G. Chandler M.A. M.D. (Canb.), F.R.C.P. (Lond.) and W. Burton Wood, M.A. M.D. (Canb.), M.R.C.P. (Lond.). New York and London: Oxford University Press, 1928.

for other monographs. In a few pages they have presented the history of lipiodol, the technique of giving it, and a few words about the indications and contra-indications, while the remaining 100 pages of the book are taken up with about 50 excellent radiograms showing various intrathoracic conditions. By means of these radiograms, by means of the short notes under each one, they describe graphically the appearances found in bronchiectasis, lung abscess, empyema, etc.

That they prefer to give iodine by means of cricothyroid puncture and not as so many of us do in this country by means of some sort of aspiration method or some method of instilling the lipiodol into the trachea through the mouth cannot be offered in criticism of the book, because in spite of their preference they describe these methods even showing roentgenograms in which several of these methods have been used and in which they have obtained the same excellency in their plates as they have with the cricothyroid puncture.

RALPH B. BETTMAN

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**MORTALITY STATISTICS 1927** 28th Annual Report Part I. United States Department of Commerce Bureau of the Census. Washington: U.S. Government Printing Office, 1929.

**DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY** By Hamilton Bailey F.R.C.S. (Eng.) New York: William Wood & Company, 1930.

**TRANSACTIONS OF THE AMERICAN PROCTOLOGIC SOCIETY** Thirtieth Annual Session Held at Hotel Statler Detroit Michigan May 13th, 14th and 15th 1929. Owatonna Minnesota: Journal Chronicle Co., 1930.

**SURGERY AT THE NEW YORK HOSPITAL ONE HUNDREN YEARS AGO** By Eugene H. Pool and Frank J. McGowan. New York: Paul B. Hoeber, 1930.

**THE CREED OF A BIOLOGIST: A BIOLOGIC PHILOSOPHY OF LIFE** By Aldred Scott Warthin Ph.D. M.D. LL.D. New York: Paul B. Hoeber, 1930.

**THE BELLEVUE HOSPITAL NOMENCLATURE OF DISEASES AND CONDITIONS** DEPARTMENT OF HOSPITALS, CITY OF NEW YORK. Rev. by the Committee on Clinical Records. Approved by Dr. William Schroeder Jr. Commissioner. 1929. New York: Paul B. Hoeber, 1930.

**HUMAN BIOLOGY AND RACIAL WELFARE** Edited by Edmund V. Cowdry Ph.D. Introduction by Edwin R. Embree. New York: Paul B. Hoeber, 1930.

**A TEXT BOOK OF PSYCHIATRY FOR STUDENTS AND PRACTITIONERS** By D. K. Henderson M.D. (Glas.) M.R.C.P. D.P.M. (Lond.) 2d ed. New York and London: Oxford University Press, 1930.

**BULLETIN OF THE NATIONAL RESEARCH COUNCIL. A SURVEY OF THE LAW CONCERNING DEAD HUMAN BODIES ISSUED UNDER THE AUSPICES OF THE COMMITTEE ON MEDICOLEGAL PROBLEMS** By George H. Weismann LL.B. Washington: The National Research Council of the National Academy of Sciences, 1929.

**GYNECOLOGY FOR NURSES AND GYNECOLOGICAL NURSING** By Conyns Berkeley M.A. M.D. MC (Canb.) F.R.C.P. (Lond.) F.R.C.S. (Eng.) rev. New York: G. P. Putnam's Sons, 1930.

**PROCEDURE IN EXAMINATION OF THE LUNGS WITH SPECIAL REFERENCE TO THE DIAGNOSIS OF TUBERCULOSIS** By Arthur F. Kretzer M.D. With a Foreword by James Alexander Miller M.D. New York: Oxford University Press, 1930.

**SUBSTANDARD LIVES AND THEIR ASSESSMENT IN LIFE ASSURANCE** Compiled by Jehangir J. Cursetji M.D. L.R.C.P. L.R.C.S. L.M. & S. F.C.P.S. (Bombay) J.P. F.R.S.M. (Lond.) 2d ed. rev. Bombay: The Indian Daily Mail, 1929.

**DIE SCHWANGERSCHAFTSDIAGNOSE AUS DEM HAREN (ASCHHEIM VONDEK REAKTION) PRAKTIISCHE UND WISSENSCHAFTLICHE ERGEBNISSE AUS TAUSEND HORMONALYEN HAERANALYSEN** By Dr. S. Aschheim Berlin: S. Karger, 1930.

**DIE FUNKTION DER WEIBLICHEN GESCHLECHTSORGANE UND IIRE BEZIEHUNGEN ZUM GESAMTORGANISMUS FÜR AERFTE UND STUDIERENDE** By Dr. Alexander v. Fekete Berlin: S. Karger, 1930.

**O EXAME FACIOAL DO RIMEM CIRURGIA INAPURAL** THESIS FACULTY OF MEDICINE OF S. PAULO. By Dr. Geraldo V. de Azevedo S. Paulo: Heros Graphica Editora, 1929.

**A TEXTBOOK OF ORTHOPAEDIC NURSING** By Evelyn C. Pearce. With a foreword by Sir Robert Jones Bart. K.B.E. CB. F.R.C.S. and an introductory chapter by Dame Agnes Hunt DBE. R.R.C. New York: G. P. Putnam's Sons, 1930.

**LECTURES UPON THE NURSING OF INFECTIOUS DISEASES** By F. J. Woolacott M.A. M.D. B.Ch. (Oxon.) D.P.H. rev. by Dorothy C. Hare CBE M.D. M.R.C.P. D.P.H. New York: G. P. Putnam's Sons, 1930.

**O INSTITUTO PORTUGUES PARA O ESTUDO DO CAUERO** (UNIVERSIDADE DE LISBOA FACULDADE DE MEDICINA) By F. Gentil. Reprint from Arquivo de Patologia vol. III no 1 Lisbon, 1928.

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Attendance at the Philadelphia session will be limited to a number that can be comfortably accommodated at the clinics, under which plan it will be necessary for those who wish to attend to register in advance paying the registration fee of \$5.00. Attendance at the clinics will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of visiting surgeons among the several clinics and insures against overcrowding. The number of tickets issued for any clinic being limited to the capacity of the room in which that clinic will be given.

by manipulation. They are cases with adhesions functional or hysterical cases unreduced dislocations or subluxations and a miscellaneous group. He outlines, under diagnosis, the various symptoms of adhesions as follows: limitation of movement, pain, weakness, tenderness and recurrent effusion. He discusses manipulative procedures of hip, knee, ankle, and foot, shoulder, elbow, wrist, hand and spine.

The author's qualifications are excellent. His material is well chosen and presented. The discussion on osteopathy and chiropractic should be read generally by the profession. This small book should be of value to every orthopedic, industrial, or traumatic surgeon.

PHILIP LEWIN M.D.

**CHANDLER** and **Burton Wood** have written a monograph on lipiodol in the diagnosis of thoracic disease<sup>1</sup> which might well be used as an example.

*LIPIODOL IN THE DIAGNOSIS OF THORACIC DISEASE.* By F. G. Chandler M.A. M.D. (Cantab.), F.R.C.P. (Lond.) and W. Burton Wood, M.A. M.D. (Cantab.), M.R.C.P. (Lond.). New York and London: Oxford University Press, 1928.

for other monographs. In a few pages they have presented the history of lipiodol, the technique of giving it, and a few words about the indications and contra-indications, while the remaining 100 pages of the book are taken up with about 50 excellent radiograms showing various intrathoracic conditions. By means of these radiograms by means of the short notes under each one they describe graphically the appearances found in bronchiectasis, lung abscess, empyema, etc.

That they prefer to give iodine by means of crico-thyroid puncture and not as so many of us do in this country by means of some sort of aspiration method or some method of instilling the lipiodol into the trachea through the mouth cannot be offered in criticism of the book, because in spite of their preference they describe these methods even showing roentgenograms in which several of these methods have been used and in which they have obtained the same excellency in their plates as they have with the cricothyroid puncture.

RALPH B. BETTMAN

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**MORTALITY STATISTICS 1927** 28th Annual Report Part I. United States Department of Commerce Bureau of the Census. Washington: U.S. Government Printing Office, 1929.

**DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY.** By Hamilton Bailey, F.R.C.S. (Eng.). New York: William Wood & Company, 1930.

**TRANSACTIONS OF THE AMERICAN PROCTOLOGIC SOCIETY** Thirtieth Annual Session Held at Hotel Statler, Detroit, Michigan, May 13th, 14th and 15th, 1929. Owatonna, Minnesota: Journal Chitonic Co., 1930.

**SURGERY AT THE NEW YORK HOSPITAL ONE HUNDRED YEARS AGO.** By Eugene H. Pool and Frank J. McGowan. New York: Paul B. Hoeber, 1930.

**THE CREED OF A BIOLOGIST: A BIOLOGIC PHILOSOPHY OF LIFE.** By Aldred Scott Warthin, Ph.D., M.D., LL.D. New York: Paul B. Hoeber, 1930.

**THE BELLEVUE HOSPITAL NOMENCLATURE OF DISEASES AND CONDITIONS.** DEPARTMENT OF HOSPITALS, CITY OF NEW YORK. Rev. by the Committee on Clinical Records. Approved by Dr. William Schroeder, Jr., Commissioner, 1929. New York: Paul B. Hoeber, 1930.

**HUMAN BIOLOGY AND RACIAL WELFARE.** Edited by Edmund V. Cowdry, Ph.D. Introduction by Edwin R. Embree. New York: Paul B. Hoeber, 1930.

**A TEXT BOOK OF PSYCHIATRY FOR STUDENTS AND PRACTITIONERS.** By D. K. Henderson, M.D. (Glas.). M.R.C.P. D.P.M. (Lond.). 2nd ed. New York and London: Oxford University Press, 1930.

**BULLETIN OF THE NATIONAL RESEARCH COUNCIL. A SURVEY OF THE LAW CONCERNING DEAD HUMAN BODIES ISSUED UNDER THE AUSPICES OF THE COMMITTEE ON MEDICOLEGAL PROBLEMS.** By George H. Weimann, LL.B. Washington: The National Research Council of the National Academy of Sciences, 1929.

**GYNECOLOGY FOR NURSES AND GYNECOLOGICAL NURSING.** By Conyns Berkeley, M.A., M.D., M.C. (Cantab.), F.R.C.P. (Lond.), F.R.C.S. (Eng.). rev. New York: G. P. Putnam's Sons, 1930.

**PROCEDURE IN EXAMINATION OF THE LUNGS WITH SPECIAL REFERENCE TO THE DIAGNOSIS OF TUBERCULOSIS.** By Arthur F. Kraetzer, M.D. With a Foreword by James Alexander Miller, M.D. New York: Oxford University Press, 1930.

**STANDARD LIVES AND THEIR ASSESSMENT IN LIFE ASSURANCE.** Compiled by Jehangir J. Cursetji, M.D., L.R.C.P., L.R.C.S., L.M. & S., F.C.P.S. (Bombay), J.P. F.R.S.M. (Lond.). 2nd ed. rev. Bombay: The Indian Daily Mail, 1929.

**DIE SCHWANGERSCHAFTSDIAGNOSTIK AUS DEM HARNE (ASCHHEIM-LODNER REAKTION). PRAKTIISCHE UND WISSENSCHAFTLICHE ERGEBNISSE AUS TAUSEND HORMONALEN HARNANALYSEN.** By Dr. S. Aschheim, Berlin. S. Karger, 1930.

**DIE FUNKTION DER WEIBLICHEN GESCHLECHTSORGANE UND IHRE BEZIEHUNGEN ZUM GESAMTORGANISMUS. FÜR ARZTE UND STUDIERENDE.** By Dr. Alexander v. Fekete, Berlin. S. Karger, 1930.

**O EXAME FUNCIONAL DO RIMEM CIRURGIA INACURAL.** THESE FACULTY OF MEDICINE OF S. PAULO. By Dr. Geraldo V. de Azevedo, S. Paulo. Heros Graphica, Editora, 1929.

**A TEXTBOOK OF ORTHOPAEDIC NURSING.** By Evelyn C. Pearce. With a foreword by Sir Robert Jones, Bart., F.R.C.S. and an introductory chapter by Dame Agnes Hunt, D.B.E., F.R.C. New York: G. P. Putnam's Sons, 1930.

**LECTURES UPON THE NURSING OF INFECTIOUS DISEASES.** By F. J. Woolcott, M.A., M.D., B.Ch. (Oxon.), D.P.H. rev. by Dorothy C. Hare, C.B.E., M.D., M.R.C.P., D.P.H. New York: G. P. Putnam's Sons, 1930.

**O INSTITUTO PORTUGUÊS PARA O ESTUDO DO CANCRO (UNIVERSIDADE DE LISBOA FACULDADE DE MEDICINA).** By F. Gentil. Reprint from Arquivo de Patologia, vol. III, no. 1, Lisbon, 1928.

## SAMARITAN HOSPITAL

## Monday

- WILLIAM A STEEL—1 Surgical operations  
 W HERSEY THOMAS—3 Genito urinary surgery  
 TEMPLE FAY—3 Surgical treatment of epilepsy  
 EUGENE P PENDERGRASS—3 Surgical radiologic conference  
 roentgenologic diagnosis of hypertrophied gastric mucosa and pedunculated tumors of the stomach prolapsing into the duodenum  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Tuesday

- TEMPLE FAY—9 Neurosurgical clinic encephalography  
 W WAYNE BABCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 HARRY HUDSON—1 Orthopedic surgery  
 TEMPLE FAY—3 Management of traumatic injuries to the brain  
 EUGENE P PENDERGRASS—3 Surgical radiological conference  
 roentgenologic diagnosis of liver abscess and subdiaphragmatic collections  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Wednesday

- WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic spinal cord tumor cases  
 W WAYNE BABCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 WILLIAM A STEEL—1 General surgical operations  
 H Z HOSHMAN—3 Atypical neuralgia and trigeminal neuralgia  
 EUGENE P PENDERGRASS—3 Surgical radiological conference  
 roentgenologic study of the neck and upper respiratory tract  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Thursday

- TEMPLE FAY—9 Neurosurgical clinic cerebellar tumor cases  
 W WAYNE BABCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12 Operative gynecology  
 WILLIAM A STEEL—12 Buerger's clinic operative and ambulant cases  
 JESSE ARNOLD—1 Obstetrics  
 TEMPLE FAY—3 Neurosurgical clinic hydration states normal in eclampsia and uremia and acute toxic states  
 EUGENE P PENDERGRASS—3 Surgical radiological conference  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Friday

- WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic gangliectomy or sympathectomy  
 W WAYNE BABCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12 Operative gynecology

- WILLIAM A STEEL—1 Operative surgery  
 W HERSEY THOMAS—3 Genito urinary operations  
 TEMPLE FAY—3 Neurosurgical clinic  
 EUGENE P PENDERGRASS—3 Surgical radiological conference  
 encephalography  
 FRANK W KONZELMAN—4 Surgical pathological conference

## GRADUATE HOSPITAL

## Monday

- GEORGE E PFAHLER—2 Radiation in diagnosis of malignant diseases  
 GEORGE PIERSON—2 Dry clinic Cardiorenal cases  
 ORLANDO PETTY—4 Demonstration of diabetes cases

## Tuesday

- H L BOCKUS—9 Gastro intestinal diagnosis  
 WALTER E LEE—9 General surgical clinic  
 B A THOMAS—2 Genito urinary operations

## Wednesday

- JOHN P JOHNSON—9 General surgery  
 H L BOCKUS—2 Gastro intestinal diagnosis  
 EUGENE A CASE—3 Surgical pathology  
 GEORGE PIERSON—3 Dry clinic Cardiorenal cases

## Thursday

- EUGENE A CASE—3 Surgical pathology  
 C F MARTIN and W O HERMANCE—9 Rectal infections

## Friday

- J B CARNETT—9 General surgical clinic  
 B A THOMAS—2 Genito urinary operations  
 GEORGE PIERSON—2 Dry clinic Cardiorenal cases  
 GEORGE E PFAHLER—3 Radiation in diagnosis and treatment of malignant diseases

## ST AGNES HOSPITAL

## Tuesday

- E C MURPHY—9 General surgical clinic  
 LEONARD AVERETT—10 Gynecological clinic

## Wednesday

- J W BRANSFIELD—9 General surgical clinic  
 G M DORRANCE—2 General surgery and cleft palate clinic

## Thursday

- J F X JONES—9 General surgical clinic  
 JOHN A MCGILLY—10 Gynecological clinic  
 W W VAN DOLSEN—11 Obstetrical clinic

## Friday

- G M DORRANCE—9 General surgical clinic

## NORTHEASTERN HOSPITAL

## Tuesday

- E C DAVIS—2 Proctology  
 T T THOMAS and J C SCOTT—3 Dry clinic fractures and dislocations

## Wednesday

- J B LOWNES—4 Genito urinary surgery

## Thursday

- J S RAEDENBLSH—2 Gynecology and obstetrics  
 T T THOMAS—3 General surgery

## PRELIMINARY CLINICAL PROGRAM

## GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS

## UNIVERSITY HOSPITAL

## Tuesday

CHARLES C. NORRIS, C. A. BEHNEY and D. P. MURPHY  
—9 Gynecological operations and demonstration of cases

DRS. MULLER OVERHOLT and RADEMAKER—9 Surgical clinic abdominal cases

EDMUND B. PIPER and staff—9 Obstetrical operations

C. H. FRAZIER and F. C. GRANT—9 Neurosurgical clinic

DRS. MULLER OVERHOLT and RADEMAKER—2 Dry clinic. Special tests used in the study of vascular disturbances; opaque solutions available in the roentgenological study of surgical patients; factors in the production of chills following intravenous infusions; intraperitoneal and intrapleural pressure relation ships; the course of events in acute appendicitis

I. S. RAYDIN—2 Gall bladder surgery operations and demonstration of cases

C. H. FRAZIER and F. C. GRANT—2 30 Neurosurgical clinic demonstration of interesting cases

## Wednesday

FLOYD E. KEENE and staff—9 Gynecological operations

E. L. ELIASON and staff—9 General surgical clinic

F. C. GRANT—9 Neurosurgical clinic

A. BRUCE GILL and staff—2 Orthopedic surgery dry clinic with demonstration of end results

## Thursday

C. H. FRAZIER and F. C. GRANT—9 Neurosurgical operations

DRS. MULLER OVERHOLT and RADEMAKER—9 Surgical clinic thoracic cases; operations and demonstration of cases

EDMUND B. PIPER and staff—9 Obstetrical operations

DRS. MULLER OVERHOLT and RADEMAKER—2 Dry clinic. Results in the surgical treatment of lung abscess; methods of treating empyema; presentation of follow up chest cases of lung abscess; bronchiectasis; chronic empyema and pulmonary tuberculosis

A. BRUCE GILL and staff—2 Orthopedic operations

B. J. ALPERT—2 30 Neuropathological conference

## Friday

C. H. FRAZIER—9 Neurosurgical clinic

FLOYD E. KEENE and staff—9 Gynecological operation

EDMUND B. PIPER—9 Obstetrical operations

E. L. ELIASON and staff—9 Fracture clinic

## PENNSYLVANIA HOSPITAL

## Tuesday

CHARLES F. MITCHELL and associates—9 Surgical clinic

## Wednesday

JOHN H. GIBBON and associates—9 Surgical clinic

## Thursday

CHARLES F. MITCHELL and associates—9 Surgical clinic

## Friday

JOHN H. GIBBON and associates—9 Surgical clinic

## JEFFERSON HOSPITAL

## Tuesday

P. BROOKE BLAND and staff—9 Gynecology and obstetrics

J. TORRANCE RUGH and staff—10 Orthopedics

J. CHALMERS DA COSTA and staff—11 General surgery

THOMAS C. STELLWAGEN and staff—11 Genito-urinary surgery

JOHN H. GIBBON and staff—2 General surgery

## Wednesday

BROOKE M. ANSPACH and staff—9 Gynecology

P. BROOKE BLAND and staff—9 Gynecology and obstetrics

THOMAS C. STELLWAGEN and staff—11 Genito-urinary surgery

J. CHALMERS DA COSTA and staff—2 General surgery

## Thursday

P. BROOKE BLAND and staff—9 Gynecology and obstetrics

THOMAS C. STELLWAGEN and staff—10 Genito-urinary surgery

J. CHALMERS DA COSTA and staff—11 General surgery

J. TORRANCE RUGH and staff—11 Orthopedic surgery

P. BROOKE BLAND and staff—4 Obstetrics

## Friday

BROOKE M. ANSPACH and staff—9 Gynecology

P. BROOKE BLAND and staff—9 Gynecology and obstetrics

THOMAS C. STELLWAGEN and staff—11 Genito-urinary surgery

JOHN H. GIBBON—11 General surgery

## ORTHOPEDIC HOSPITAL

## Tuesday

A. P. C. ASHBURST, R. L. JOHN and E. T. CROSSAN—1 Out patient clinic

A. B. GILL—9 Orthopedic operations

## Thursday

A. P. C. ASHBURST—9 Orthopedic operations

WILLIAM J. TAYLOR—1 Out patient clinic

## Friday

WILLIAM J. TAYLOR—1 Orthopedic operations

## FRANKFORD HOSPITAL

## Tuesday

C. F. NASSAU, L. D. ENGLERTH and B. CHANDLER—9 General surgery

## Wednesday

EDWARD SCHUMANN and FREDERICK KELLER—9 Gynecological clinic

## Thursday

W. E. PARKE—9 Gynecological clinic

GEORGE HANNA—9 Obstetrical clinic

L. D. ENGLERTH and B. CHANDLER—2 Fracture clinic





## LANKENAU HOSPITAL

## Monday

JOHN B. DEEVER—12 General surgical clinic  
WILLIAM MACKINNEY—3 Cystoscopy

## Tuesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration

## Wednesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
COLBY ENGEL—9 Injection treatment of varicose veins  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
JOHN B. DEEVER—12 General surgical clinic

## Thursday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
JOHN B. DEEVER—12 General surgical clinic

## Friday

COLBY ENGEL—9 Injection treatment of varicose veins  
STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
WILLIAM MACKINNEY—3 Cystoscopy

## ST JOSEPH'S HOSPITAL

## Monday

FRANCIS J. McCULLOUGH—3 Obstetrical clinic

## Tuesday

MELVIN M. FRANKLIN—9 Fractures in children  
F. HURST MAIER—10 Gynecological operations

## Wednesday

JAMES A. KELLY—9 General surgical clinic  
JOHN F. V. JONES—9 General surgical clinic

## Thursday

ALEXANDER E. BURKE—8 Gynecological surgery  
F. HURST MAIER—10 Gynecological surgery  
CHARLES F. NASSAU—10 General surgery

## Friday

MELVIN M. FRANKLIN—9 Surgery of children  
FRANCIS J. McCULLOUGH—3 Obstetrical clinic

## JEWISH HOSPITAL

## Tuesday

PHILIP WILLIAMS and E. SCHUMANN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic  
WILLIAM H. KELLER—3 General surgical operations

## Wednesday

FRANK B. BLOCK—9 General surgical operations  
MOSES BEHREND—11 General surgical clinic  
THOMAS STELLWAGEN and JOHN B. LOWNES—2 Urological operations  
LEON BRINKMANN—2 General surgical operations

## Thursday

MOSES BEHREND—9 General surgical clinic moving pictures gastro enterological cases

## Friday

PHILIP WILLIAMS and E. SCHUMANN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic  
WILLIAM H. KELLER—3 General surgical operations

## NORTHWESTERN GENERAL HOSPITAL

## Monday

J. S. RAUDENBUSH—2 Gynecology

## Tuesday

J. B. MENCKE, ROBERT BOYER and E. B. PARKER—9 General surgical operations  
ARTHUR D. KURTZ—2 30 Orthopedic clinic

## Wednesday

J. B. MENCKE, ROBERT BOYER and E. B. PARKER—9 General surgical operations  
J. S. RAUDENBUSH—12 Gynecology  
E. C. DAVIS—3 Rectal clinic

## Thursday

J. B. MENCKE, ROBERT BOYER and E. B. PARKER—9 General surgical operations  
L. F. MILLIKEN—2 30 Genito urinary surgery

## CHESTNUT HILL HOSPITAL

## Tuesday

JOHN McCLOSKEY—10 30 General surgical clinic  
Drs. SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## Thursday

CHARLES BEHNEY—9 Operative gynecology  
ALEXANDER RANDALL—9 Urological clinic

## Friday

W. C. SHEEHAN and L. HERGESHEIMER—9 General surgery  
Drs. SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## ST CHRISTOPHER'S HOSPITAL

## Tuesday

Staff—10 General surgery

## Friday

R. L. JOHN—20 Orthopedics

## PRESBYTERIAN HOSPITAL

## Tuesday

E. B. HODGE and H. P. BROWN—9 General surgery  
A. B. GILL and T. ORR—2 Orthopedics

## Wednesday

D. B. PREIFFER and J. S. RODMAN—9 General surgery  
B. A. THOMAS, J. C. BIRDALL and F. G. HARRISON—2  
Genito-urinary surgery

## Thursday

I. H. JOPSON and W. E. CHRISTIE—9 General surgical  
operations  
J. H. GIVIN, G. M. LAWS and J. P. LEWIS—2 Gynecological operations

## Friday

J. SPEER and F. A. BOTHE—9 General surgery

## MT SINAI HOSPITAL

## Monday

MOSES BEHREND—1 15 General surgical operations

## Tuesday

BENJAMIN LIPSHUTZ—9 General surgical operations  
ALEXANDER RANDALL—1 30 Urological clinic operations and demonstration of cases

## Wednesday

CHARLES MAZER—9 Operative gynecology  
MORRIS COOPERMAN—2 Orthopedic clinic operations and demonstration of cases

## Thursday

BERNARD MANN—9 Operative gynecology  
ALEXANDER RANDALL—1 30 Urological clinic operations and demonstration of cases

## Friday

BENJAMIN LIPSHUTZ—9 General surgical operations and demonstration of cases  
MOSES BEHREND—1 General surgical operations and demonstration of cases

## KENSINGTON HOSPITAL FOR WOMEN

## Tuesday

H. C. DEAYER—12 General surgery

## Wednesday

WILLIAM E. PARKE—10 General surgery  
JOHN B. HAINES—3 30 Cystoscopic clinic

## Friday

H. C. DEAYER—12 General surgery

## AMERICAN ONCOLOGIC HOSPITAL

## Tuesday

ALBERT F. BOTHE, CHARLES E. CODMAN, GEORGE M. DOBRANCE, WILLIAM C. HUEPER, BRADY A. HUGHES, C. B. LONGNECKER, SAMUEL MCCLARY III, ELLICE McDONALD, WILLIAM S. NEWCOMET, DAMON B. PREIFFER, WILLIAM D. ROBINSON, JESSE W. SMITH, WILLIAM H. SPENCER and S. E. GRACY—9 Clinical conference with exhibition of patients. Fibroid tumors, breast cases, congenital mouth cases, hemangiomas, etc.

## PHILADELPHIA GENERAL HOSPITAL

## Tuesday

M. P. WARMUTH—9 General surgery  
FRANK C. HAMMOND—9 Gynecology and obstetrics

## Wednesday

J. T. RUGH—9 Orthopedics  
HUBERT OWEN—2 General surgery

## Thursday

JOHN O. BOWER—9 General surgery  
F. A. SCHUMANN—9 Gynecology and obstetrics  
WILLIAM H. MACKINNEY—2 Genito-urinary surgery

## Friday

HARVEY M. RICHTER—9 General surgery  
Staff—2 X-ray demonstration

## ST. LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

## Tuesday

A. B. WEBSTER—9 Surgical clinic  
WARREN C. MERCER and staff—9 Obstetrical clinic

## Wednesday

HERBERT P. LEOPOLD and staff—9 Surgical clinic  
WILLIAM C. HUNTSICKER and staff—9 Urological clinic

## Thursday

H. K. ROESSLER—9 Surgical clinic  
RICHARD W. LARER, JOHN A. BROOKE and staff—9 Orthopedic clinic  
JAMES D. SCHOFIELD and staff—9 Clinic on diseases of the rectum  
WELTON D. BAYLEY and associates—2 Neurosurgical symposium on injuries of the head  
FRANK C. BENSON and staff—2 Dry clinic. Indications and contra-indications for use of radium in myopathies, hemorrhage  
G. MORRIS GOLDEN and group—2 Dry clinic and symposium on pre and postoperative problems of toxic goiter

## METHODIST EPISCOPAL HOSPITAL

## Tuesday

DAMON B. PREIFFER and CALVIN M. SMYTH, JR.—9 General surgical operations

## Wednesday

JOHN C. HIRST and LEONARD HAMBLOCK—9 Operative gynecology and obstetrics  
JAMES H. BALDWIN—9 General surgical operations

## Thursday

GEORGE SCHWARTZ—9 General surgical operations

## Friday

DAMON B. PREIFFER and CALVIN M. SMYTH, JR.—9 General surgical operations

## GERMANTOWN HOSPITAL

## Wednesday

WILLIAM B. SWARTLEY—10 General surgery

## Friday

WILLIAM B. SWARTLEY—10 General surgery

## LANKENAU HOSPITAL

## Monday

JOHN B DEEVER—12 General surgical clinic  
WILLIAM MACKENNEY—3 Cystoscopy

## Tuesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration

## Wednesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
COLBY ENGEL—9 Injection treatment of varicose veins  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
JOHN B DEEVER—12 General surgical clinic

## Thursday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
JOHN B DEEVER—12 General surgical clinic

## Friday

COLBY ENGEL—9 Injection treatment of varicose veins  
STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
WILLIAM MACKENNEY—3 Cystoscopy

## ST JOSEPH'S HOSPITAL

## Monday

FRANCIS J McCULLOUGH—3 Obstetrical clinic

## Tuesday

MELVIN M FRANKLIN—9 Fractures in children  
F HURST MAIER—10 Gynecological operations

## Wednesday

JAMES A KELLY—9 General surgical clinic  
JOHN F X JONES—9 General surgical clinic

## Thursday

ALEXANDER E BURKE—8 Gynecological surgery  
F HURST MAIER—10 Gynecological surgery  
CHARLES F NASSAU—10 General surgery

## Friday

MELVIN M FRANKLIN—9 Surgery of children  
FRANCIS J McCULLOUGH—3 Obstetrical clinic

## JEWISH HOSPITAL

## Tuesday

PHILLIP WILLIAMS and E SCHUMANN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic  
WILLIAM H KELLER—2 General surgical operations

## Wednesday

FRANK B BLOCK—9 General surgical operations  
MOSES BEHREND—11 General surgical clinic  
THOMAS STELLWAGEN and JOHN B LOWMYER—2 Urological operations  
LEON BRENNMAN—2 General surgical operations

## Thursday

MOSES BEHREND—9 General surgical clinic moving pictures gastro-enterological cases.

## Friday

PHILLIP WILLIAMS and E SCHUMANN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic  
WILLIAM H KELLER—2 General surgical operations

## NORTHWESTERN GENERAL HOSPITAL

## Monday

J S RAUDENBUSH—2 Gynecology

## Tuesday

J B MENCKE ROBERT BOYER and E B PARKER—9 General surgical operations  
ARTHUR D KURTZ—2 30 Orthopedic clinic.

## Wednesday

J B MENCKE ROBERT BOYER and E B PARKER—9 General surgical operations  
J S RAUDENBUSH—12 Gynecology  
E C DAVIS—3 Rectal clinic

## Thursday

J B MENCKE ROBERT BOYER and E B PARKER—9 General surgical operations  
L F MILLIKEN—2 30 Genito-urinary surgery

## CHESTNUT HILL HOSPITAL

## Tuesday

JOHN McCLOSKEY—10 30 General surgical clinic  
DRS. SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## Thursday

CHARLES BEENEY—9 Operative gynecology  
ALEXANDER RANDALL—9 Urological clinic.

## Friday

W C SHEEHAN and L HERGENHEIMER—9 General surgery  
DRS. SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## ST CHRISTOPHER'S HOSPITAL

## Tuesday

Staff—10 General surgery

## Friday

R L JOHN—10 Orthopedics.

## PRESBYTERIAN HOSPITAL

## Tuesday

E. B. HODGE and H. P. BROWN—9 General surgery  
A. B. GILL and T. ORR—2 Orthopedics

## Wednesday

D. B. PFEIFFER and J. S. RODMAN—9 General surgery  
B. A. THOMAS, J. C. BIRDALL and F. G. HARRISON—2  
Genito-urinary surgery

## Thursday

J. H. JORSON and W. E. CHRISTIE—9 General surgical  
operations  
J. H. GIVIN, G. M. LAWS and J. P. LEWIS—2 Gynecological operations

## Friday

J. SPEESE and F. A. BOTHE—9 General surgery

## MT SINAI HOSPITAL

## Monday

MOSES BEREND—1 15 General surgical operations

## Tuesday

BENJAMIN LIPSHUTZ—9 General surgical operations  
ALEXANDER RANDALL—1 30 Urological clinic, operations and demonstration of cases

## Wednesday

CHARLES MAZER—9 Operative gynecology  
MORRIS COOPERMAN—2 Orthopedic clinic operations and demonstration of cases

## Thursday

BENJAMIN LIPSHUTZ—9 Operative gynecology  
ALEXANDER RANDALL—1 30 Urological clinic operations and demonstration of cases

## Friday

BENJAMIN LIPSHUTZ—9 General surgical operations and demonstration of cases  
MOSES BEREND—1 General surgical operations and demonstration of cases

## KENSINGTON HOSPITAL FOR WOMEN

## Tuesday

H. C. DEAYER—12 General surgery

## Wednesday

WILLIAM E. PARKE—10 General surgery  
JOHN B. HAINES—3 30 Cystoscopic clinic

## Friday

H. C. DEAYER—12 General surgery

## AMERICAN ONCOLOGIC HOSPITAL

## Tuesday

ALBERT E. BOTHE, CHARLES E. CODMAN, GEORGE M. DORRANCE, WILLIAM C. HUEFNER, BRADY A. HUGHES, C. B. LONGNECKER, SAMUEL MCCLARY III, ELLICE McDONALD, WILLIAM S. NEWCOMET, DAMON B. PFEIFFER, WILLIAM D. ROBINSON, JESSE W. SMITH, WILLIAM H. SPENCER and S. E. TRACY—9 Clinical conference with exhibition of patients. Fibroid tumors, breast cases, congenital mouth cases, hemangiomas, etc.

## PHILADELPHIA GENERAL HOSPITAL

## Tuesday

M. P. WARMUTH—9 General surgery  
FRANK C. HAMMOND—9 Gynecology and obstetrics

## Wednesday

J. T. RUGH—9 Orthopedics  
HUBLEY OWEN—2 General surgery

## Thursday

JOHN O. BOWER—9 General surgery  
E. A. SCHUMANN—9 Gynecology and obstetrics  
WILLIAM H. MACKENNEY—2 Genito-urinary surgery

## Friday

HARVEY M. RICHTER—9 General surgery  
Staff—2 X-ray demonstration

## ST. LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

## Tuesday

A. B. WEBSTER—9 Surgical clinic  
WARREN C. MERCER and staff—9 Obstetrical clinic

## Wednesday

HERBERT P. LEOPOLD and staff—9 Surgical clinic  
WILLIAM C. HUNYCKER and staff—9 Urological clinic

## Thursday

H. K. ROESSLER—9 Surgical clinic  
RICHARD W. LARER, JOHN A. BROOKE and staff—9 Orthopedic clinic  
JAMES D. SCHOFIELD and Staff—9 Clinic on diseases of the rectum  
WESTON D. BAYLEY and associates—2 Neurosurgical symposium on injuries of the head  
FRANK C. BENSON and staff—2 Dry clinic. Indications and contra indications for use of radium in myopathic hemorrhage  
G. MORRIS GOLDEN and group—2 Dry clinic and symposium on pre and postoperative problems of toxic goiter

## METHODIST EPISCOPAL HOSPITAL

## Tuesday

DAMON B. PFEIFFER and CALVIN M. SMYTH JR—9 General surgical operations

## Wednesday

JOHN C. HIRST and LEONARD HAMBLOCK—9 Operative gynecology and obstetrics  
JAMES H. BALDWIN—9 General surgical operations

## Thursday

GEORGE SCHWARTZ—9 General surgical operations

## Friday

DAMON B. PFEIFFER and CALVIN M. SMYTH JR—9 General surgical operations

## GERMANTOWN HOSPITAL

## Wednesday

WILLIAM B. SWARTLEY—10 General surgery

## Friday

WILLIAM B. SWARTLEY—10 General surgery

## LANKENAU HOSPITAL

## Monday

JOHN B. DEEVER—12 General surgical clinic  
WILLIAM MACKENNEY—3 Cystoscopy

## Tuesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration

## Wednesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
COLBY ENGEL—9 Injection treatment of varicose veins  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
JOHN B. DEEVER—12 General surgical clinic

## Thursday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
JOHN B. DEEVER—12 General surgical clinic

## Friday

COLBY ENGEL—9 Injection treatment of varicose veins  
STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR. HAMMETT—9 Chemistry of cell division  
MRS. MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOWMAKER—11 X ray demonstration  
WILLIAM MACKENNEY—3 Cystoscopy

## ST JOSEPH'S HOSPITAL

## Monday

FRANCIS J. MCCULLOUGH—3 Obstetrical clinic

## Tuesday

MELVIN M. FRANKLIN—9 Fractures in children  
F. HURST MAIER—10 Gynecological operations

## Wednesday

JAMES A. KELLY—9 General surgical clinic  
JOHN F. X. JONES—9 General surgical clinic

## Thursday

ALEXANDER E. BURKE—8 Gynecological surgery  
F. HURST MAIER—10 Gynecological surgery  
CHARLES F. NASSAU—10 General surgery

## Friday

MELVIN M. FRANKLIN—9 Surgery of children  
FRANCIS J. MCCULLOUGH—3 Obstetrical clinic

## JEWISH HOSPITAL

## Tuesday

PHILLIP WILLIAMS and E. SCHUMANN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic  
WILLIAM H. KELLER—2 General surgical operations

## Wednesday

FRANK B. BLOCH—9 General surgical operations  
MOSES BEHREND—11 General surgical clinic  
THOMAS STELLWAGEN and JOHN B. LOWMEYER—2 Urological operations  
LEOY BRINKMANN—2 General surgical operations

## Thursday

MOSES BEHREND—9 General surgical clinic moving pictures gastro enterological cases

## Friday

PHILLIP WILLIAMS and E. SCHUMANN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic  
WILLIAM H. KELLER—2 General surgical operations.

## NORTHWESTERN GENERAL HOSPITAL

## Monday

J. S. RAUDENBUSH—2 Gynecology

## Tuesday

J. B. MENCKE, ROBERT BOYER and E. B. PARKER—9 General surgical operations  
ARTHUR D. KURTZ—2 30 Orthopedic clinic

## Wednesday

J. B. MENCKE, ROBERT BOYER and E. B. PARKER—9 General surgical operations  
J. S. RAUDENBUSH—12 Gynecology  
E. C. DAVIS—3 Rectal clinic

## Thursday

J. B. MENCKE, ROBERT BOYER and E. B. PARKER—9 General surgical operations  
L. F. MILLIKEN—2 30 Genito-urinary surgery

## CHESTNUT HILL HOSPITAL

## Tuesday

JOHN McCLOSKEY—10 30 General surgical clinic  
DRS. SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## Thursday

CHARLES BERNY—9 Operative gynecology  
ALEXANDER RANDALL—9 Urological clinic

## Friday

W. C. SHEERAN and L. HERGESHEIMER—9 General surgery  
DRS. SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## ST CHRISTOPHER'S HOSPITAL

## Tuesday

Staff—10 General surgery

## Friday

R. L. JOHN—10 Orthopedics.

## PRESBYTERIAN HOSPITAL

## Tuesday

E B HODGE and H P BROWN—9 General surgery  
A B GILL and I ORR—2 Orthopedics

## Wednesday

D B PFEIFFER and J S RODMAN—9 General surgery  
B A THOMAS, J C BIRDALL and F G HARRISON—2  
Genito-urinary surgery

## Thursday

J H JOYSON and W E CHURCH—9 General surgical  
operations  
J H GURVIN, G M LAWS and J P LEWIS—2 Gynecological operations

## Friday

J SPEISE and F A BOTHE—9 General surgery

## MT SINAI HOSPITAL

## Monday

MOSES BEHREND—1 15 General surgical operations

## Tuesday

BENJAMIN LIPSCHUTZ—9 General surgical operations  
ALEXANDER RANDALL—1 30 Urological clinic operations and demonstration of cases

## Wednesday

CHARLES MAZER—9 Operative gynecology  
MORRIS COOPERMAN—2 Orthopedic clinic operations and demonstration of cases

## Thursday

BERNARD MANN—9 Operative gynecology  
ALEXANDER RANDALL—1 30 Urological clinic operations and demonstration of cases

## Friday

BENJAMIN LIPSCHUTZ—9 General surgical operations and demonstration of cases  
MOSES BEHREND—1 General surgical operations and demonstration of cases

## KENSINGTON HOSPITAL FOR WOMEN

## Tuesday

H C CLAVER—12 General surgery

## Wednesday

WILLIAM E PARKE—10 General surgery  
JOHN B HAINES—3 30 Cystoscopic clinic

## Friday

H C CLAVER—12 General surgery

## AMERICAN ONCOLOGIC HOSPITAL

## Tuesday

ALBERT E BOTHE, CHARLES E COOKMAN, GEORGE M DORRANCE, WILLIAM C HUEPPE, BRADY A HUGHES, C B LONGNECKER, SAMUEL McCLEARY III, ELLIOTT McDONALD, WILLIAM S NEWCOMB, DAMON B PFEIFFER, WILLIAM D ROBINSON, JESSE W SMITH, WILLIAM H SPENCER and S F TRACY—9 Clinical conference with exhibition of patients: Fibroid tumors, breast cases, congenital mouth cases, hemangiomas, etc.

## PHILADELPHIA GENERAL HOSPITAL

## Tuesday

M P WARMUTH—9 General surgery  
FRANK C HAMMOND—9 Gynecology and obstetrics

## Wednesday

J T ROTH—9 Orthopedics  
HUBLEY OWEN—2 General surgery

## Thursday

JOHN O BOWER—9 General surgery  
E A SCHUMANN—9 Gynecology and obstetrics  
WILLIAM H MACKENNEY—2 Genito-urinary surgery

## Friday

HARVEY M RIGTER—9 General surgery  
Staff—2 X ray demonstration

## ST LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

## Tuesday

A B WEBSTER—9 Surgical clinic  
WARREN C MERCER and staff—9 Obstetrical clinic

## Wednesday

HERBERT P LEOPOLD and staff—9 Surgical clinic  
WILLIAM C HUNSTICKER and staff—9 Urological clinic

## Thursday

H K ROESSLER—9 Surgical clinic  
RICHARD W LARER, JOHN A BROOKE and staff—9 Orthopedic clinic  
JAMES D SCHOFIELD and Staff—9 Clinic on diseases of the rectum  
WESTON D BAYLEY and associates—2 Neurosurgical symposium on injuries of the head  
FRANK C BENSON and staff—2 Dry clinic: Indications and contra indications for use of radium in myopathic hemorrhage  
G MORRIS GOLDEN and group—2 Dry clinic and symposium on pre and postoperative problems of toxic goiter

## METHODIST EPISCOPAL HOSPITAL

## Tuesday

DAMON B PFEIFFER and CALVIN M SMYTH JR—9 General surgical operations

## Wednesday

JOHN C HIRST and LEONARD HAMBLOCK—9 Operative gynecology and obstetrics  
JAMES H BALDWIN—9 General surgical operations

## Thursday

GEORGE SCHWARTZ—9 General surgical operations

## Friday

DAMON B PFEIFFER and CALVIN M SMYTH JR—9 General surgical operations

## GERMANTOWN HOSPITAL

## Wednesday

WILLIAM B SWARTLEY—10 General surgery

## Friday

WILLIAM B SWARTLEY—10 General surgery

## EPISCOPAL HOSPITAL

## Monday

H C DEEVER—1 30 General surgical clinic

## Tuesday

LOUIS H MUTSCHLER—11 30 General surgical clinic

JOHN B HAINES—2 Urological clinic

TEMPLE FAY—2 Neurosurgical clinic

## Wednesday

A P C ASHURST—9 General surgical clinic

R L JOHN—1 30 Orthopedic clinic

R S BROMER—2 X ray demonstration

## Thursday

ROBERT H IVY—9 Oral surgery

F G ALEXANDER—9 General surgical clinic

H C DEEVER—1 30 General surgical clinic

## Friday

LOUIS H MUTSCHLER—11 30 General surgical clinic

JOHN B HAINES—2 Urological clinic

## ST MARY'S HOSPITAL

## Tuesday

JAMES A KELLY—9 General surgery

WILLIAM J RYAN—9 General surgery

WILLIAM E PARKE—1 Obstetrical clinic

## Wednesday

A P KEEGAN—9 General surgery

WILLIAM MORRISON—9 Gynecology

## Thursday

HENRY K SEELAUS—9 General surgery

JOSEPH TOLAND—9 Gynecology

J STUART LAWRENCE—1 Obstetrical clinic

## Friday

P A MCCARTHY—9 General surgery

LEO WOJCZYNSKI—9 Gynecology

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

## Tuesday

JOHN DEAN ELLIOTT T C GEARY and THOMAS DOYLE

—9 General surgical clinic

LEON T ASHCRAFT—2 Urological surgery

## Wednesday

JOHN A BROOKE—2 Orthopedic surgery

## Thursday

NATHANIEL F LAKE—2 Gynecological clinic

NEWLEN F PAXSON—2 Lipiodol study of fallopian tubes

## Friday

WARREN C MERCER—2 Postnatal clinic

## WOMAN'S HOMEOPATHIC HOSPITAL

## Tuesday

FRANCIS L HUGHES—9 Gynecological clinic

## Wednesday

ARTHUR HARTLEY—9 General surgical clinic

## MISERICORDIA HOSPITAL

## Tuesday

J A KELLY and B R BELTRAN—9 General surgical operations

F MCGOVERO—11 Pre and postoperative care

## Wednesday

G P MULLER and T RYAN—9 General surgical operations

DR DOUGHERTY—11 Fractures of the femur

## Thursday

J A KELLY and B R BELTRAN—9 General surgical operations

J A SHARKEY and D C GRIST—11 Blood transfusion operative results in fractures

## Friday

G P MULLER and T RYAN—9 General surgical operations

J B CARDONE and E J GARVIN—11 General surgical clinic

## WOMAN'S MEDICAL COLLEGE HOSPITAL

## Tuesday

HUBLEY R OWEN—9 General surgery

## Wednesday

MARGARET C STURGIS—9 Demonstration of the use of carbon dioxide tubal insufflation and uterosalpingograms in the diagnosis of sterility

## Thursday

CATHERINE MACFARLANE—9 Gynecological clinic

## Friday

JOHN S RODMAN—9 General surgery

## PENNSYLVANIA HOSPITAL

(Maternity Department and Lying in Hospital)

## Tuesday

N W LAUX and staff—9 Obstetrics and gynecology

## Wednesday

E B PIPER and staff—9 Obstetrics and gynecology

## Thursday

N W LAUX and staff—9 Obstetrics and gynecology

## Friday

E B PIPER and staff—9 Obstetrics and gynecology

## WOMAN'S HOSPITAL

## Tuesday

EMILY W ALGE—9 General surgery

## Wednesday

FAITH S FETTERMAN—9 Cystoscopic demonstration

## Thursday

LIDA S COGILL—2 Obstetrical demonstration

## Friday

MARIE FORMAD—9 Gynecological clinic

## LOOPFR HOSPITAL

(Camden)

*Tuesday*

P M MEGRAY A S ROSS F W SHAFER and I E DEIBERT—9 General surgical operations  
T B LEE A B DAVIS and G F WEST—9 Operative gynecology and obstetrics  
I E DEIBERT and R S GAMON—10 Fracture clinic

*Wednesday*

I M MEGRAY A S ROSS F W SHAFER and I E DEIBERT—9 General surgical operations  
B F BUZBY—9 Operative orthopedics  
A H LIPPINCOTT and D F BENTLEY—2 Urological operations  
P M MEGRAY A S ROSS F W SHAFER and I E DEIBERT—2 End results in fracture cases  
B F BUZBY—3 Demonstration of orthopedic cast and end results

*Thursday*

P M MEGRAY A S ROSS F W SHAFER and I E DEIBERT—9 General surgical operations  
T B LEE A B DAVIS and G F WEST—9 Operative gynecology and obstetrics  
A S ROSS—2 End results in industrial injuries (New Jersey State Clinic)

*Friday*

P M MEGRAY A S ROSS F W SHAFER and I E DEIBERT—9 General surgical operations  
B F BUZBY—9 Operative orthopedics  
I E DEIBERT and R S GAMON—10 Fracture clinic

## CHILDREN'S HOSPITAL

WALTER ESTEL LEE surgical clinic  
WILLIAM A JAQUETTE Dental clinic  
HOWARD CHILDS CARPENTER Preventive medicine in reference to surgical diseases in children  
SUSAN C FRA CEN R N Hospital management from surgical viewpoint  
J C GITTINGS Medical aspect of surgical cases in children  
RALPH S BRUMER Roentgenological aspect of children's diseases  
EDWARD F LOKOV Bone syphilis and other allied surgical conditions  
C C NIERI Vaginitis clinic

## EVANS DENTAL INSTITUTE

*Tuesday*

ROBERT H IVY—9 Fracture of the jaw

*Wednesday*

LAURENCE CURTIS—9 Oral surgical clinic

*Thursday*

ROBERT H IVY and LAWRENCE CURTIS—9 Oral surgical clinic

## BABIS HOSPITAL

*Tuesday*

JOHN SINCLAIR and WILLIAM BATES—2 30 Presentation of follow up cases of intussusception and congenital hypertrophic stenosis

*Thursday*

JOHN SINCLAIR and I BENDER—2 30 Conservative treatment of cervical adenitis.

## HAHNEMANN HOSPITAL

*Monday*

H P LEOPOLD—1 Hernia clinic  
D B JAMES and staff—2 Operative gynecology

*Tuesday*

D B WEBSTER—0 Fracture clinic.  
JOHN E JAMES and staff—2 Obstetrics  
L T ASHCRAFT and staff—2 Genito urinary surgery

*Wednesday*

L T ASHCRAFT and FRANK BENSON—9 Neoplasms of the genito urinary tract  
H L NORTHPROP—2 General surgical clinic

*Thursday*

J DEAN ELLIOTT—9 General surgical clinic  
D B JAMES and staff—9 Operative gynecology  
JOHN A BROOKE and staff—2 Dry clinic orthopedic surgery

*Friday*

H L NORTHPROP and staff—9 General surgical clinic  
FRANK BENSON—9 Indications for radium treatment

## STETSON HOSPITAL

*Monday*

CARL F KOENIG—1 30 X ray demonstration

*Tuesday*

WILLIAM T ELLIS and JOHN A BOGER—12 General surgery

*Wednesday*

STEPHEN E TRACY—8 30 Gynecology  
CARL F KOENIG—1 30 X ray demonstration

*Friday*

STEPHEN E TRACY—8 30 Gynecology  
CARL F KOENIG—1 30 X ray demonstration

## JFANES HOSPITAL

*Wednesday*

R W TEAHAN—2 Carcinoma of breast  
C A WHITCOMB—2 Lung tumors  
E E DOWNS—2 The saturation method of X ray treatment  
W S HASTINGS—2 Exhibition of interesting pathological specimens

*Thursday*

R W TEAHAN—2 Carcinoma of skin.  
C A WHITCOMB—2 Mediastinal masses  
E E DOWNS—2 Exhibition of interesting X ray films  
W S HASTINGS—2 Exhibition of interesting pathological specimens.

## U S NAVAL HOSPITAL

*Tuesday*

Staff—9 Surgical operations

*Wednesday*

Staff—9 Surgical operations.

*Thursday*

Staff—9 Surgical operations

*Friday*

Staff—2 Discussion of surgical cases or surgical topics



## SURGERY OF THE EYE, EAR, NOSE AND THROAT

## JEFFERSON HOSPITAL

## Tuesday

LOUIS H. CLERF and staff—9 Bronchoscopy  
F. O. LEWIS and staff—9 Nose and throat operations

## Wednesday

F. O. LEWIS and staff—10 Carcinoma of larynx  
LOUIS H. CLERF and staff—11 Bronchoscopy

## Thursday

LOUIS H. CLERF and staff—9 Bronchoscopy  
F. O. LEWIS and staff—9 Nose and throat operations

## Friday

C. F. G. SHANNON and staff—3 Ophthalmology

## MT SINAI HOSPITAL

## Monday

C. W. LEFEVER—3 30 Eye clinic operations and demonstration of cases

## Tuesday

LEWIS FISHER—1 Ear nose and throat clinic, operation and demonstration of cases

## Wednesday

DAVID HUSK—2 30 Ear nose and throat clinic  
GABRIEL TUCKER—4 Bronchoscopy

## Thursday

MORRIS WEINSTEIN—2 Ear nose and throat clinic operations and demonstration of cases

## Friday

MATTHEW ERSNER—1 Ear nose and throat clinic operations and demonstration of cases

## ST JOSEPH'S HOSPITAL

## Tuesday

GEORGE MORLEY MARSHALL—9 The Marshall operation for nasal deformity with end results  
A. J. KEENE—3 Otolaryngological operations

## Wednesday

ARTHUR W. WIGLEY—9 Otolaryngological operations

## Thursday

GEORGE MORLEY MARSHALL—9 The radical mastoid with end results  
C. T. MCCARTHY—2 Otolaryngological operations

## Friday

FRANCIS GOWEN—9 Otolaryngological operations

## UNIVERSITY HOSPITAL

## Wednesday

GEORGE FETTEROLF and staff—2 Otolaryngological clinic operations and demonstration of cases

## Friday

GEORGE FETTEROLF and staff—2 Otolaryngological clinic operations and demonstration of cases  
T. B. HOLLOWAY—4 Ophthalmological clinic

## SAMARITAN HOSPITAL

## Monday

MATTHEW ERSNER—3 Operative otology

## Tuesday

CHEVALIER JACKSON and associates—8 30 Bronchoscopic clinic

ROBERT RIDPATH—2 Laryngological clinic  
LUTHER C. PETER—3 Operative ophthalmology

## Wednesday

CHEVALIER JACKSON and associates—8 30 Bronchoscopic clinic

## Thursday

CHEVALIER JACKSON and associates—8 30 Bronchoscopic clinic

ROBERT RIDPATH—2 Operative laryngology  
LUTHER C. PETER—4 Ophthalmological surgery

## Friday

CHEVALIER JACKSON—8 30 Bronchoscopic clinic  
MATTHEW ERSNER—4 Otological clinic

## EPISCOPAL HOSPITAL

## Monday

FREDERICK KRAUS—2 Eye clinic  
W. R. WATSON—2 Ear nose and throat clinic

## Tuesday

HAROLD VON GOLDBERG— Eye clinic

## Wednesday

W. R. WATSON—1 30 Ear nose and throat clinic  
A. C. FENWELL—3 Eye clinic

## Thursday

C. C. BIEDERT—1 30 Ear nose and throat clinic  
FREDERICK KRAUS—1 30 Eye clinic

## Friday

C. C. BIEDERT—1 30 Ear nose and throat clinic  
HAROLD VON GOLDBERG—1 30 Eye clinic

## JEWISH HOSPITAL

## Wednesday

J. C. KNIFE—3 Ophthalmological operations

## Thursday

A. S. KAUFMAN and R. F. RIDPATH—2 Otolaryngological operations

## ST MARY'S HOSPITAL

## Tuesday

WILLIAM GRADY—3 Otolaryngology

## Wednesday

F. A. MURPHY—3 Ophthalmology

## Thursday

R. T. M. DUNNELL—3 Ophthalmology  
EDWARD MURPHY—3 Otolaryngology

## LANEVAU HOSPITAL

## Monday

W J CREIGHTON and DR SMITH—1 Eye clinic

## Tuesday

W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BARBITT—2 Ear nose and throat clinic.

## Wednesday

W J CREIGHTON and DR SMITH—1 Eye clinic

## Friday

W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BARBITT—2 Ear nose and throat clinic

## ST CHRISTOPHER'S HOSPITAL

## Monday

H J WILLIAMS or E H CAMPBELL—1 30 Nose and throat clinic

## Wednesday

H J WILLIAMS or E H CAMPBELL—9 Nose and throat clinic.

## Thursday

DR FELDMAN—10 Eye clinic

## Friday

H J WILLIAMS or E H CAMPBELL—1 30 Nose and throat clinic

## NORTHWESTERN GENERAL HOSPITAL

## Tuesday

M S ERSNER H S WIEDER and M A ZACKS—2 Nose and throat clinic

## Thursday

M S ERSNER H S WIEDER and M A ZACKS—2 Nose and throat clinic.  
S H BROWN—3 Eye clinic

## PHILADELPHIA GENERAL HOSPITAL

## Tuesday

ROBERT J HUNTER—2 Laryngology

## Friday

L WALLER DEICHLER—9 Ophthalmology

## FRANKFORD HOSPITAL

## Tuesday

FRANK EMBERY and ROBERT WATT—2 Ear nose and throat clinic

## Wednesday

WILLIAM H CHANDLER—2 Eye clinic  
DR RICHARDSON—2 Ear nose and throat clinic.

## NORTHEASTERN HOSPITAL

## Wednesday

GEORGE E SHAFER—2 Sinus disease  
C A LAWRENCE—3 Ophthalmology

## GRADUATE HOSPITAL

## Monday

R BUTLER G M COATES S R SKILLERN G B WOOD and E B GLEASON—2 Ear nose and throat clinic

## Tuesday

R BUTLER G M COATES S R SKILLERN G B WOOD and E B GLEASON—2 Ear nose and throat clinic demonstration of cases of intercostal neuralgia

## Thursday

CHEVALIER JACKSON—9 Bronchoscopic clinic

## MISERICORDIA HOSPITAL

## Monday

J E LOFTUS—2 Otolaryngological operations

## Tuesday

C T MCCARTHY—2 Otolaryngological operations

## Wednesday

J E LOFTUS—2 Otolaryngological operations

## Thursday

C T MCCARTHY—2 Otolaryngological operations

## Friday

J E LOFTUS—2 Otolaryngological operations

## CHESTNUT HILL HOSPITAL

## Tuesday

JOHN R DAVIES—1 Ear nose and throat clinic.

## Wednesday

BENJAMIN D PARRISH—1 30 Ear nose and throat clinic

## Thursday

JOHN R DAVIES—2 Ear nose and throat clinic  
CARL WILLIAMS—2 Ophthalmology

## Friday

BENJAMIN PARRISH—1 30 Ear nose and throat clinic

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

## Thursday

GILBERT J PALEN CARROLL T HAINES H BAILEY CHALFONT and EVERETT A TYLER—2 Tonsillectomy and adenoidectomy clinic, adults and children under gas anesthesia

## WOMAN'S HOMEOPATHIC HOSPITAL

## Thursday

JOSEPH V F CLAY J R CRISWELL and CHARLES J FRIES JR.—9 Nose and throat clinic.

## WOMAN'S MEDICAL COLLEGE HOSPITAL

## Tuesday

MARGARET F BUTLER—2 Ear nose and throat clinic

## Friday

MARGARET F BUTLER—2 Ear nose and throat clinic

## PRESBYTERIAN HOSPITAL

*Monday*

H M LANGDON and J M THORINGTON—2 Ophthalmology

*Friday*

N P STAUFFER, W CARISS and O R KLINE—2 Otolaryngological operations

## COOPER HOSPITAL

(Camden)

*Tuesday*

A M ELWELL—2 Otolaryngological operations

*Thursday*

A M ELWELL—2 Otolaryngological operations

## ST LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

*Tuesday*

CHARLES B HOLLIS and staff—9 Ear nose and throat clinic

## WILLS EYE HOSPITAL

STAFF—2 daily Ophthalmological clinics operations and demonstration of cases.

## HAHNEMANN HOSPITAL

*Tuesday*

H S WEAVER and staff—2 Ear nose and throat clinic

*Thursday*

H S WEAVER and staff—2 Ear nose and throat clinic

*Friday*

FRANK NAGLE and FRED PETERS—9 Cataract Operations

## ST AGNES HOSPITAL

*Tuesday*

BENJAMIN D PARRISH—1 Ear nose and throat clinic

*Wednesday*

GEORGE F J KELLY—2 30 Ophthalmological clinic

## CHILDREN'S HOSPITAL

JAMES A BARRITT and associates Nose and throat clinic

EDWARD SHUMWAY Eye clinic

## STETSON HOSPITAL

*Thursday*

CARL LEE FELT—12 Ear nose and throat clinic

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